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THE OLDEST RAILROAD PAPER IN THE WORLD.

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WATER seems to have been an unusually destructive element this year. The floods in Pennsylvania are referred to elsewhere, and the people along the lower Mississippi have been and are still engaged in a prolonged effort to secure their levees from destruction by the river, which has been as high, or higher, than ever before. In some cases they have succeeded by hard and well-directed work, but in several places there have been dangerous *crevasses* which have flooded a large extent of country.

The question of holding the Mississippi in check and disposing of the flood waters grows more difficult every year; and it presents a problem which may require the best thought and ability of engineers.

IF the reports telegraphed to the daily papers be true, Dr. Justin has at last succeeded in his efforts to use shells loaded with high explosives with an ordinary gun and a powder charge. His latest tests are said to have had very successful results; but after the long series of failures in this direction some doubt may be expressed, at any rate, until fuller reports are made.

THE purchase of the Louisville, New Orleans & Texas Railroad by the Illinois Central Company is a railroad event of some importance, giving the last-named company control of two good north-and-south lines, and substantially freeing it from the competition of any strong line south of the Ohio. It is another step in that process of consolidation which is so marked a feature of the present railroad era.

THE Special Commission to which the Supreme Court, under the provisions of the law, referred the report of the New York Rapid Transit Commission, has submitted its report. This approves the plan for a four-track underground road through the center of the city as far north as Union Square, and thence up the west side to the city limits; the line in the upper part of the city to be partly under and partly above ground, according to the varying nature of the surface. The approval of the proposed east side line is limited to a road as far north as 44th Street, any action as to the rest being prevented by an act passed by the last Legislature prohibiting the use of Madison Avenue, which had been chosen by the Rapid Transit Commission.

The Court will probably keep this report under consideration for some time before deciding upon it. Should it be approved, the franchise for the proposed lines will be offered at public sale to any parties who will undertake to build and operate them.

IT now seems probable that the Ordnance Department of the Army will get a liberal appropriation for the completion of the gun factory at the Watervliet Arsenal. This factory has been well planned and managed, and the additional plant which the appropriation provides will put it in condition for doing good work on the largest class of guns.

THE New York Central has lately put in use on its suburban trains a number of locomotives burning anthracite coal, much to the relief of travelers and residents along the line. The use of bituminous coal with the accompanying smoke on locomotives running through such crowded residence districts as those along the Harlem Division and the lower end of the Hudson River Division is a "relic of barbarism" which ought not to be permitted. The new engines, by the way, are of the ordinary eight-wheel pattern, and not of the type illustrated in our columns some time ago, although those engines are said to have done very well.

THE Pennsylvania Railroad has had several locomotives built in different shops and of different styles, which are to be tried in its fast passenger service, in comparison with the established types now in use on the road. Two of these engines are from the Schenectady Works, one being an eight-wheel engine and the other a ten-wheel, two-cylinder compound; a third is a ten-wheel engine from the Baldwin Works, of the Vauclain four-cylinder compound type.

THERE seems to be some prospect of the completion of the Chigneto Ship Canal, and work on the hydraulic lifts at the northern terminus was recommenced early in June. The iron-work and machinery for this was completed some time ago. It is understood that the Company has secured means for going on with the work at any rate, if not enough to complete it.

THE Cape Cod Ship Canal project, which has been brought up so many times, and upon which work has been begun on several different occasions, has always been unfortunate, and notwithstanding the obvious advantages of the canal, no Company has yet succeeded in bringing it anywhere near completion. The latest corporation which has hold of the project tried to secure some aid from the State of Massachusetts, but the Legislature of that State has put so decided a veto upon it that there is no probability of the attempt being renewed.

OTHER ship canal projects, however, seem to promise better. Professor Haupt is sanguine as to the prospects of his proposed canal between the Delaware and New York Bay. His plan, it will be remembered, provides for the enlargement of a part of the present Delaware & Raritan Canal, which will cover nearly one-half the distance

and the building of a new canal for the remaining half; from an engineering point of view this is a perfectly feasible project, the only question being as to the commercial value of the canal when completed.

THE tests ordinarily adopted for color-blindness have never seemed to us altogether trustworthy; and although they have met with general acceptance, this opinion seems to be supported by the British Society of Arts. At a recent meeting of that Association, a paper on Color-Blindness was read, and in that paper and the discussion which followed strong ground was taken against the ordinary tests. Persons who had had considerable experience in making them maintain that on the one hand they could be used in an unfair way, while upon the other it was comparatively easy for a person with a little previous instruction to evade their requirements. A new and more satisfactory set of tests is recommended, athough experts are not agreed as to what programme should be followed.

THE project for an electrical railroad between Chicago and St. Louis, which is advocated by Dr. Adams, and to which some reference has heretofore been made, does not seem to meet altogether with the approval of the experts in the Electrical Engineers' Society. Dr. Adams recently delivered a lecture before that Society on his plan, which was sharply criticised, and some high authorities expressed serious doubts as to its practicability in the present state of the science, although few were willing to say that something like it might not be carried out in the future.

IT is stated that the Short Electric Company, of Cleveland, through its Engineer, has made a proposition to the Manhattan Elevated Railroad in New York for the running of its trains by electricity. The proposition, it seems, was not accepted, the Manhattan Company being somewhat doubtful as to the result, although the engineer who designed the proposed system was perfectly confident. To run the trains on the Third Avenue line of the road, for instance, would be a much greater undertaking than any electric company has yet ventured upon. As in the instance previously referred to, it would be rash to predict that it will not be done within a few years; but to judge only by what has already been accomplished, the Company seems to be justified in expressing some doubt as to the result. It may be said, however, that the New York elevated lines present about as favorable conditions as could be found for the use of electricity as a motor, and if the experiment could be tried there the results would be interesting.

IT is to be noted that both the great political parties this year have inserted in their platforms resolutions favoring legislation for the adoption of safety appliances on railroad cars. This is significant, because it shows a belief on the part of men who are accustomed to watch public opinion that there is a popular interest in the question which is worth considering. It will also serve to indicate the importance of railroads and railroad questions in modern life.

THE Government of the Argentine Republic has carried official regulation of railroads to a greater extreme, probably, than that of any other country, excepting, of course, those in which the railroads are owned directly by the State. As a general rule the interferences of the State is confined to the regulation of rates and similar matters, and to certain requirements intended to secure safety in operation, but the Argentine Government has recently gone much further. In one case we are told a large lot of rails imported for the use of one of the lines had been thrown aside because the Government inspectors refused to allow them to be laid, not because they were of poor material or too light, but because the section did not suit the views of the inspector. It is said that a plan is in preparation requiring all railroad lines to use rails of uniform section, and that the Government also proposes to adopt certain types of locomotives and cars to which all the roads must correspond. How far this will be carried is still uncertain, but it is quite possible that such unnecessary regulation may produce a reaction to the other extreme.

A NEW company, which has just been organized in New York, proposes to build a tunnel extending under the North and East Rivers from Jersey City to Brooklyn, and connecting the Long Island Railroad with the Pennsylvania and the other roads having their terminal stations on the west side of the Hudson. The articles of incorporation also contain clauses providing for the underground connection of both Brooklyn and Jersey City with the lower part of New York City. But little has been said about this company, but it is reported to have the backing of Mr. Austin Corbin and some other heavy capitalists who are quite able to provide the means for carrying it through.

THE SIBERIAN RAILROAD.

THE actual commencement of work on the Western Siberian Railroad is an event which ought to attract attention all over the world. As our Russian correspondent tells in another column, the location of the road has been finally approved, and an appropriation made which will put the graders at work. Although it is now too late in the short Siberian season to accomplish very much this year, it is an earnest of the future, and there is no doubt that next year substantial progress will be made.

The Siberian Railroad has several features which ought to draw attention to the work. In the first place, it will be the longest continuous railroad line in the world. It is the only great transcontinental line now under construction, if we except the comparatively very short Transandine Railroad in South America, and it presents many engineering features of interest. The building of the road through the difficult mountain region of the Trans-Baikal; its operation in the rigorous climate of Eastern Siberia, and the crossings of a number of rivers of great size are all points which will require much engineering skill and ability.

The commercial results of the building of the road may also be considerable, and may tend to make considerable changes in some old trade routes. It will take time to accomplish these, however, even after the road is completed, for trade changes slowly although surely.

It must also be remembered that Western Siberia now presents the only great unoccupied area of land which is open to occupation and cultivation by civilized man, for the tropical regions of Africa can hardly be considered in such a connection. The climate is not more severe than

that of Manitoba or perhaps North Dakota, and much of the land is of good quality. Central Siberia can never be an agricultural country, but it has great resources in minerals and timber which the railroad will develop. On the Pacific end of the road there is a very fertile country still almost unoccupied, which presents many inducements for settlement.

Finally the road will so strengthen the military position of Russia as to make that State the dominant power in Eastern Asia, and to give it a position like that it already holds in Central Asia, a controlling influence which no other European power can shake.

All these are considerations which will doubtless fully support the Russian Government in its intention to build the railroad with all possible speed. It is interesting to know that American ingenuity is appreciated by the Russian engineers, and that American methods and machinery will be largely adopted in construction.

DAMS AND FLOODS.

OUR readers are all familiar through the daily papers with the details of the flood in the Oil Creek Valley by which the flourishing towns of Titusville and Oil City in Pennsylvania were recently almost destroyed, and the circumstances seem to call for some comment. The catastrophe there was only second to the memorable one at Johnstown in its terrible results, the loss of life and the devastation of a prosperous district, while in the towns themselves the horrors of a fire, spread and carried on by the water itself, were added to the flood. That the loss of life was not as great as at Johnstown was due chiefly to the fact that the wider spread of the valley did not permit so great a concentration of the flood, and gave more time and opportunity for escape.

While there would probably have been some damage done in any case by the overflow due to long-continued heavy rains, it would probably have been so limited in its nature as hardly to attract any special notice, had not the flood been concentrated in its effects, as it were, by the addition to it of the water stored up by a dam at Spartansburg, on the upper waters of the stream. A great body of water was here held in check and was then suddenly set free by the breaking of the dam, and rushed down the valley with a force which carried everything before it.

This dam seems to have been a structure hardly sufficient for its purpose in ordinary seasons, and certainly not to be relied upon in one like the present. It was, apparently, an earth and rock dam built up in a haphazard sort of way, and added to from time to time as more storage of water seemed desirable. It had certainly not been built or maintained with any special care, and no one seems to know just what was expected of it, or what its real condition was. Probably the forces before which it finally gave way had been acting for some time, and its failure was simply a question of days.

Two points seem to be impressed upon us by this affair. The first is the old axiom which cannot be too often impressed upon the builders and owners of dams—engineers may be supposed to know and realize its importance—that "the overflow *must* be sufficient to carry off any surplus of water and prevent any rise from overtopping the dam. No earth dam can long withstand the running of water over its crest, which is surely fatal to the structure."

In this case the water seems to have risen above the crest—the dam was already leaking—and after that the utter failure was a question only of time, and of a very short time.

This lesson was further impressed upon us a week or two later by a nearly similar failure of an earth dam, and by the following flood, which almost destroyed the mining town of Mahanoy City, in Eastern Pennsylvania. In that case the element of fire was absent, but serious loss of life was prevented only by the presence of mind and prompt action of two or three men who saw that the dam was giving way, and warned the people of the valley below.

The number of dams and reservoirs in nearly all the States is increasing constantly with the increased demand for water power and for storage for city and town supplies and for irrigation. It is clearly a duty, in the interest of public safety, to insist upon a careful supervision of the construction and maintenance of such structures. This duty has been too much neglected in the past, and there are not more than three or four States in which there is even any systematic attempt at proper control, while in many of them it is ignored altogether.

An incidental lesson from the Oil City catastrophe is that greater care should be exercised in selecting places for tanks and storage of oil in bulk. The near neighborhood of such tanks to towns and villages must be always a source of danger, and their location should be so chosen that the least possible damage may result in case of fire or failure of a tank. They should also be scattered as much as possible, so that accident may be confined to a single tank, and its extension to a great body of oil avoided.

THE MASTER CAR-BUILDERS' CONVENTION.

THE inexorable calendar has again brought around the dates when the masters of car-building, with their wives and daughters, are in the habit of flocking together at some extensive and more or less agreeable hotel where entertainment can be provided for some hundreds of people who annually attend these meetings. This year the place selected was Saratoga, which is, perhaps, better suited than any other for the holding of such meetings. The time when they are held—about the middle of June—is before the opening of the regular season at the great hotels, so that there is always room and to spare for all who come. There are few attractions besides the meetings sufficiently alluring to entice members away from them, so that there is nearly always a better attendance when the conventions are held in Saratoga than there is in any other place. The aperient effect of the waters also seems to assuage animosities, so that the amity of these assemblages is less disturbed here than it is elsewhere.

There was nothing especially notable in the journey from New York to Saratoga, which was made on the celebrated Empire State Express as far as Albany, excepting to note the success of this celebrated train. All the seats, excepting an uncomfortable one in the corner of the smoking compartment, were taken the night before the departure of the train, and all the other cars were filled. It was predicted of this train that it would not pay, but it is said to be one of the best-paying passenger trains on the New York Central Railroad. Of the run not much is to be said. It is not uncommon to travel even on local trains at speeds quite as high as this train attains, and it is also not unusual, on limited trains, to run long distances, at limited speed, without stopping ; but the Empire State Express runs without stopping the whole distance from New York to Albany, and keeps up a high rate all the way.

A little criticism of the drawing-room car would, perhaps, not be out of place here. The writer was unfortunate in securing

a poor seat on the sunny side of the car. The window-shade was of the usual textile material used in drawing-room and sleeping cars, and was hot and stuffy. It was not clean, and excluded the air, which leads to the remark that old-fashioned blinds with slats are in every way to be preferred to such shades. The blinds are cleaner, cooler, and permit of free circulation of air when the windows are opened. It has been a fad of late years to substitute shades for blinds on the ordinary coaches of some roads. The old-fashioned practice seems in every way to be preferable to the new innovation.

Another practice may also be noted as an advance backward —the omission of parcel-racks in drawing-room cars. This was done because such conveniences were not considered elegant, and it was thought that they detracted from the stylishness of such cars, the attainment of which end seems to be the pre-eminent motive in their construction. Hooks were provided in place of racks, on which to hang hats and coats, with the result that in cold, and even in mild weather, the interiors of these cars bear a resemblance to second-hand clothing shops. Give us the basket racks, Messrs. Car-Builders, and omit the coat and hat hooks, and your cars will gain in comfort more than they lose in tonicity.

The Association held its first meeting in the ball-room of Congress Hall, the acoustic properties of which, by the way, are wretched. The meeting was called to order by the President, John Kirby. The usual welcome by the Mayor of Saratoga, President's address, and report of Secretary were delivered, and the Convention then set sail. Since last year there was a net increase of 14 members and of 68,075 cars represented. The Treasurer's report shows a balance to the credit of the Association of $4,184, a more favorable condition of finances than has ever existed heretofore.

Abstracts of the various reports are given on another page, so that no effort will be made here to summarize them. The discussion on the Rules of Interchange was unusually protracted, and, owing to the warm weather, rather fatiguing to the members. It was at times, too, a little acrimonious.

Standard gauges for the preservation of the contour lines and thickness of the metal of the M. C. B. couplers which were ordered by the Executive Committee were submitted to the Association by the Pratt & Whitney Company, of Hartford, Conn., and the question of the adoption of them as standards was submitted to a letter ballot of the Association.

Among the significant events of the meeting was the invitation from the Superintendents' Association, asking the M. C. B. Association to send delegates to the meeting of the former. In this letter the hope is expressed that the step thus taken "may lead to mutual benefit and to an increase in usefulness of the railroad service as well."

Of the meeting generally it may be said that the attendance was larger than ever before. This is true of the members and of the "lobby" as it is called—that of persons indirectly interested in the sale and manufacture of supplies and machinery. Never before was there so much interest manifested in the proceedings. Two sessions a day were held, and on Friday afternoon it was plain that there would not be sufficient time for a proper consideration of some of the reports. One of these, on the Standards of the Association, was one of the best ever presented to the Association, and deserved a long and careful discussion. To the older members it seemed like breaking up long and cherished religious belief to propose that some of the standards should be rescinded. Around nearly all of them there clusters in the minds of the older members the recollection of a struggle more or less earnest, of discussions and argument of which the newer members are ignorant. The Committee, however, did their work so well that all who heard their report seemed to be agreed that their recommendations to rescind and modify some of the standards ought to be carried out. The discussion was, however, postponed to the meeting next year, and then the subject will doubtless be fully considered.

To the older members who have attended these meetings for twenty or more years, their gradual growth and importance is very interesting. It was only a few years ago since the effort was made to induce the railroad companies of the country to send representative members to these meetings. It then seemed to be very doubtful whether any sufficient number would accede to that request, to make the measure successful. Now the usefulness of the Association is established to such a degree that people inquire how could the business pertaining to the construction and movement of cars be carried on without it? That it has a great career of usefulness before it no one any longer doubts.

THE MASTER MECHANICS' CONVENTION.

LIKE the Master Car-Builders, the Master Mechanics' Association had a large attendance at its Saratoga meeting. The proceedings were fully up to the usual standard, and there were several interesting discussions.

Perhaps the most important and interesting report presented was that on Compound Locomotives, which was the result of much work on the part of the Committee. With the arrangements made for the use of a compound engine for tests our readers are already familiar, and the report gives an account of the experiments made with this and other engines, the results being presented as fully as possible. The Committee has not felt fully prepared to analyze the results as presented, but the general tenor of its remarks seems to be that the economy in fuel obtained with the compound engine was not so great as had been expected, and was hardly up to the point claimed by its advocates.

The tests made directly under the supervision of the Committee are supplemented by some short reports of tests made by other members of the Association. The report was very fully discussed in the Convention, with the probable result that more service trials will be made. After all, the determination of the true value and place of the compound is not a question of a few tests, but of continued use in regular service, where its cost for repairs as well as for fuel, and the work which it can do will be decided.

The Convention labored under the disadvantage of very hot weather, which does not tend to stimulate the members to much exertion; but on the whole it was a very good one, and will compare not unfavorably with its predecessors.

NEW PUBLICATIONS.

THE MEMPHIS BRIDGE; SUPERSTRUCTURE AND GENERAL PLANS. By George S. Morison, Chief Engineer. The Kansas City & Memphis Railroad & Bridge Company, Memphis, Tenn.

Mr. Morison, the Chief Engineer of the Memphis Bridge, the completion of which was recently noted, has issued an album under this title containing a number of sheets showing the general plan and much of the detailed work of the different spans of the bridge. The lithographic sheets are 44 × 19 in. in size, so that the drawings are on a fairly large scale and are easy to read. The Memphis Bridge possesses great interest on account of the extraordinary length of the spans and the many difficulties overcome in its construction, and these illustrations of the manner in which the work was done will be of much interest to engineers.

RAILWAY OFFICIALS' DIRECTORY AND GUIDE FOR THE USE OF RAILROAD MEN AND DEALERS IN RAILROAD SUPPLIES. The *Railway Age* Publishing Company, Chicago, Ill.

This is a new edition of the book which has been published for several years under the title of the "Supply Men's Direc-

tory." It gives the names and addresses of the principal officers of the railroads of the United States, Canada and Mexico, the list including the presidents, general managers, superintendents, purchasing agents, chief engineers and the heads of the motive power and car departments. It is a little book of 180 pages, of convenient form to carry in the pocket, the size being $3\frac{1}{2} \times 5\frac{1}{2}$ in. The type is necessarily rather small, but is not difficult to read, as the printing and paper are good. So far as we have been able to examine, it is carefully prepared and correct, and it is certainly a convenient and handy book for a traveling man to carry with him. An index showing the places at which different roads are represented adds to its convenience.

SUPERIOR, THE EYE OF THE NORTHWEST. ANNUAL REPORT OF THE CITY STATISTICIAN OF SUPERIOR, WISCONSIN. W. F. Street, Statistician. Published by the City, Superior, Wis.

In this pamphlet Mr. Street has grouped a large collection of figures showing the growth of the City of Superior in trade and manufactures, and giving also some information about the trade of the Northwest which, it is hoped, will be brought to that city. The many advantages of the place and the certainty of its future growth and development are also set forth.

The information is well arranged and presented, and the pamphlet is illustrated by views of some of the notable buildings, hotels, factories and others.

COMPOUND LOCOMOTIVES. The Schenectady Locomotive Works, Schenectady, N. Y.

This pamphlet contains a paper written by Mr. C. H. Hudson, General Manager of the East Tennessee, Virginia & Georgia Railroad, describing a practical test of compound locomotives in regular service. The locomotives with which the test was made were of the two-cylinder type made at the Schenectady Works, one of them being a ten-wheel passenger engine, and the other a heavy consolidation freight engine. Both were tried in comparison with simple engines of the same classes in all respects, except the cylinders, and in both cases the results were very favorable to the compounds.

The pamphlet contains, besides this paper, a description and drawings of the Pitkin intercepting valve, which is used on the Schenectady engines, and engravings of a number of compound locomotives built for different roads. There are also given a number of indicator cards taken from an engine built for the Adirondack & St. Lawrence Railroad, which was tried on the New York Central, and did some excellent work.

TIMBER PHYSICS: PART I, PRELIMINARY REPORT. B. E. Fernow, Chief of Forestry Division, Department of Agriculture. Government Printing Office, Washington.

Reference has been made in our columns from time to time to the important series of tests of strength and other qualities of timber undertaken by the Forestry Division of the Department of Agriculture. The present volume is the first report on these tests and consists of three parts. The first gives a short introduction and a number of opinions on the value of such tests. The second shows the scope and historical development of the science of Timber Physics, with references to European and American works on the subject. The third part gives an account of the methods pursued in making the tests now in progress, and is accompanied by illustrated descriptions of the machines used for the purpose.

No results are given, for the reason that the tests have only just been begun, and the results obtained are to be announced from time to time, as progress is made in the work. The report gives a fair idea of what has been undertaken and what is expected in the future.

THE RAILROAD LAW OF THE STATE OF NEW YORK. Compiled by R. C. Cumming and Michael Danaher, 1892. James B. Lyon, Albany, N. Y.; price, $1.

This must be an interesting and convenient volume not only for lawyers, but railroad managers and officers, and to some extent for that very large class of persons who are simply investors in railroad property. Its object is to give in a convenient form the complete code of law of the State of New York relating to railroads, as it stands at the present time. It contains the general law governing corporations, the stock corporation law, the general railroad law of the State governing all railroad corporations and officers, the law relating to the condemnation of property for railroad purposes, and such sections of the general code, the civil code, and the criminal code as relate to railroads, their officers and employés. Two supplements contain, one the Rapid Transit Act of 1891, which governs the construction of local roads in large cities, and the second the Federal Interstate Commerce law, which is a very convenient supplement to a book intended for railroad officers.

The amendments are all brought down to include those made at the legislative session of the present year, and lists are given of the laws formerly in force which have been repealed. The book is completed by a very full index by subjects, so that it is possible to find quickly the sections relating to any given point. While the reviewer is not a lawyer, it may be said that a careful examination of the book seems to show that the work has been thoroughly done, and that it is what it professes to be—a full compendium of the laws governing the railroads and their officers in the State of New York as they stand at the present time. A reader need hardly be told how useful and even necessary such a volume is.

WROUGHT IRON AND STEEL IN CONSTRUCTION. CONVENIENT RULES, FORMULÆ AND TABLES. The Pencoyd Iron Works; A. & P. Roberts & Company, Philadelphia.

The eighth edition of this useful hand-book has been rewritten and altered materially since the first edition was issued eight years ago, in order to meet the changing requirements of engineers, in consequence of the changes in methods of design and strength of material. The tables have been enlarged to include steel as well as iron, and much additional matter has been added.

The rules and tables given apply only to shapes made at the Pencoyd Works, but these are so various and cover so many forms—almost every kind ordinarily used in construction—that they may be said to be of general application.

The book seems to have been very carefully prepared, and eight years of application have made it possible to amend any errors and supply any deficiencies which might have existed in the first edition. It is certainly a very convenient addition to an engineer's library, and will save him much time and trouble in his calculations.

REPORT OF TESTS OF COMPOUND LOCOMOTIVES. Burnham, Williams & Company, The Baldwin Locomotive Works, Philadelphia, Pa.

This pamphlet contains a report of four tests of compound locomotives of the Vauclain pattern made at different times in comparison with simple locomotives as nearly of the same class and description as possible. The first one referred to was made on the Northern Pacific Railroad, and was of a mogul engine having $11\frac{1}{2}$ and 19×24-in. cylinders, which was tried in connection with an engine of the same type having 18×24-in. cylinders. The other tests were made on the Western New York & Pennsylvania, the Western Maryland and the Norfolk & Western roads.

The report is illustrated and accompanied by numerous tables showing results of tests and by a number of indicator diagrams taken during the tests.

TRADE CATALOGUES.

Description of Vauclain Compound Locomotives, with Suggestions for Conducting Simple Fuel Tests. Illustrated. The Baldwin Locomotive Works, Philadelphia.

This pamphlet contains a fully illustrated description of the Vauclain four-cylinder compound locomotive, the cuts showing all the details, and some account of what has been already done with this type of locomotive. It has also some useful suggestions as to the best methods of making fuel tests of locomotives in actual service.

Creosoted Piles and Timber for all Purposes; the Dead Oil of Coal Tar Process. The Eppinger & Russell Creosoting Works, Long Island City, N. Y. Illustrated.

This pamphlet gives an account of the process named for preserving timber, and is illustrated by views of specimens of treated timber after long use, contrasted with others of untreated timber with the same exposure. This process has been applied to piles, paving-blocks, ties and other timber in exposed situations, and to timber blocks employed in making underground conduits for electric wires.

Efficient Power Pumps for Every Service, and their Applications Illustrated. The Goulds Manufacturing Company, Seneca Falls, N. Y.

This handsome catalogue gives a description of several patterns of power pumps—that is, not steam pumps, but pumps driven by belts, gearing, or electric motors—and a number of illustrations showing the purposes to which they are applied for mines, factories, elevators, etc. The descriptive matter gives a clear idea of the machines and their use, and it is well supplemented by the illustrations.

Riehlé Brothers' Testing Machine Company: Illustrated Catalogue. Philadelphia.

This little volume is to be considered, the publishers say, as a memorandum, not a price-list. It gives brief illustrated accounts of the articles manufactured by the Company, which include testing machines of different kinds and of large and small capacity; hydraulic pumps; hydraulic presses; hydraulic jacks; screw and power presses for different purposes; rope-twisting machines; dynamometers; trucks and barrows of every kind; and a great variety of smaller articles for special uses, besides hoists, chains and ventilating fans.

Engineers' Handbook of Standard Wood-Working Machines. The John A. White Company, Dover, N. H.

This little book, which is of convenient size to slip into the vest-pocket, gives illustrated descriptions of some 50 different wood-working machines made by the White Company, including saws, planers, borers, mortising machines and other tools. It is neatly printed and convenient for reference.

The Berlin Iron Bridge Company's Catalogue. Office and Works, East Berlin, Conn.

The purpose of the publishers of this catalogue is stated in an introduction to it, in which it is said that

> It is our intention in this catalogue to illustrate the construction of a large number of manufacturing buildings which we have built in the last few years. Some of these are large, some small, but we have tried to illustrate all the different classes and conditions which are likely to arise. All of these illustrations are taken from photographs, or from the working drawings of the structure as actually built. The catalogue itself shows an experience in this class of work which has never been attained by any other company.

The book is 10 × 10 in. and contains 103 pages and about the same number of engravings, most of them showing the interiors of buildings constructed by this Company. Some are scale drawings showing the roofs and other portions of buildings. The engravings are made by some photographic process from pen and ink drawings. The back portion of the book contains perspective views of a number of highway bridges of the "parabolic truss" form, which is a specialty with this Company. Several railroad bridges and a view of the works complete the volume.

This Company makes a specialty of iron buildings, and the illustrations show examples of forge shops, ship-sheds, electric-light stations, paper and pulp works, brass and copper works, armories, iron and coal sheds, copper casting shop, bending shed for shipyard, machine shops, foundries, water works, rolling mills, arcade for railroad platform, and many others.

The book gives an excellent idea of the work done by the Company, and the extent to which iron and steel are now employed in the construction of buildings.

The Stow Flexible Shaft. Illustrated Catalogue of the Stow Manufacturing Company, Binghamton, N. Y.

This catalogue gives a description of the well-known flexible shafting made by the Stow Company, with accounts of a number of its applications in general use. It also describes a number of tools made by the Company, most of them being intended for use with the flexible shafts. We hope to refer to this catalogue more at length hereafter.

Catalogue of Presses, Drop-Hammers, Shears, Dies and Special Machinery. The E. W. Bliss Company (Limited), Brooklyn, N. Y.

This catalogue is received too late for the special notice which its importance and excellence deserve.

Catalogue of Drawing Instruments: Illustrated. The Ball Ball Company, Frankford, Philadelphia.

Rapid Lathe Work by a New Method: the 2 × 24 Flat Turret Lathe. Illustrated. The Jones & Lamson Machine Company, Springfield, Vermont.

CURRENT READING.

In Good Roads for June there is a paper giving the history of our First Artificial Road; articles on Asphalt and its Uses; on the Streets and Roads of Washington; on Preserving the Carriage; and the continuation of Editor Potter's excellent articles on Dirt Roads and Gravel Roads.

The June number of the Eclectic Magazine has an usually interesting selection of articles from the English magazines and reviews, including both lighter matter and more serious articles.

The July number of Scribner's Magazine is a summer number, and is appropriately given up chiefly to lighter reading. There are, however, several interesting articles of a more serious nature, including one on the Poor of Chicago, by Joseph Kirkland, and one on the Resumption of Specie Payment, by Hon. John K. Upton.

The June number of the Arena covers a wide range of subjects discussed by capable writers. Among them are the Public School System, Life Insurance, the Basis of Currency and others. There is an excellent historical article on the Swiss Lake Dwellers, and Professor Dolbear writes of some of the newly discovered properties of matter to which Mr. Tesla's experiments have called attention.

A new periodical is issued by the D. H. Ranck Publishing Company, of Indianapolis, under the title of Milling. The first number—for June—is in magazine form, has 124 pages,

handsomely printed and illustrated, and contains a number of interesting articles. It is to be devoted to the flour and milling industry as a specialty, and ought to be successful.

A new enterprise, started in Boston, is the WEEKLY BULLETIN, which gives each week a classified index of articles from the periodical press, including in its list scientific and technical journals, as well as those of more general interest. Although still in its first volume, the paper has been very successful. Its value to readers, writers, and students will be readily seen.

The STREET RAILWAY GAZETTE has passed into the possession of Mr. M. J. Sullivan, who is now editor and publisher, and has full control of the paper. It is an excellent representative of its special interest, and its appearance under the new management in an improved form will add to its attractive character. We wish our contemporary the success which it well deserves.

The fifteenth article in the POPULAR SCIENCE MONTHLY'S series on the Development of American Industries since Columbus, is published in the July number. It is on Leather-making, and, like all in the series, it is fully illustrated. Other leading articles are on Anthropological Work in America, and on Manual Training and Industrial schools, and there are several shorter papers of interest.

The latest issue of the NATIONAL GEOGRAPHIC MAGAZINE contains a very interesting account of an expedition into the Yukon District in Alaska, by Charles Willard Hayes. It is accompanied by several maps showing the topography of this almost unknown region.

The June number of OUTING opens with a beautifully illustrated article, Through Muskoka Marvel Lands, by Edward W. Sandys, in which the author draws a charming picture of holiday life, scenic beauties and black bass fishing, in one of Canada's loveliest regions for summer residence. The number is well illustrated and excellent throughout. The Maryland National Guard, by Hanson Hiss, is concluded, and forms an interesting addition to the series of military articles published in the magazine. The number is excellent summer reading.

In recent numbers of HARPER'S WEEKLY there have been excellent illustrated articles on Nicaragua; on the Chicago Exposition Buildings; on Colorado and the Great Divide; on the Floods in the West, and on the Transandine Railroad.

The June number of the ENGINEERING MAGAZINE presents a long and varied table of contents, as follows: New York's Commercial Blight, W. N. Black; the Future World's Highway, T. G. Gribble; Sanitary Progress in New York, C. F. Wingate; Creede, the New Mining Camp, A. Williams, Jr.; Engineering at Ropes' Pass, Texas, William Kent; the Modern Marine Boiler, A. B. Willitts; Testing Guns at Sandy Hook, F. A. C. Perrine; the Railroads and Wall Street, T. L. Greene; Practical Work at a Mining School, E. S. Cranson; Impending Disaster on the Mississippi, a Southern Engineer; Practical Hints on Heating, L. Allen. The special departments show a great improvement under the new editors.

The April number of the SCHOOL OF MINES QUARTERLY has, among other articles, papers on the Topographical Survey of New York, by Professor Trowbridge; a Formula for Water Power, by the same author; the Pyrometer of M. le Chatelier, by Joseph Struthers; the Path of a Locomotive Crank-pin, by George F. D. Trask.

The May number of the JOURNAL of the American Society of Naval Engineers has articles on the Screw Propellers of United States Naval Vessels, by Passed Assistant Engineer H. Webster; Method of Molding a Cylinder at the Bath Iron Works, by Assistant Engineer S. H. Leonard; Pumping Plant for the Salt Water Aquaria at Chicago, by Passed Assistant Engineer W. B. Bailey; Proposed Revision of Rules of the Steamboat Inspection Service, by Passed Assistant Engineer Walter M. McFarland; besides a variety of notes of interest.

The July number of HARPER'S MAGAZINE has an unusual number of fine illustrations. The season is observed by several articles appropriate to the National anniversary. The series of papers on the Danube is continued by one describing the little known region of the Roumanian plains. Another article describes the western frontier of Russia, and for students of politics there is much interest in a paper on the Growth of the Federal Power, by Mr. Henry Loomis Nelson.

The OVERLAND MONTHLY for July is an excellent number, and contains several valuable articles, besides the usual variety of light reading.

The June number of GOLDTHWAITE'S GEOGRAPHICAL MAGAZINE has articles on a variety of topics, including the Underground Drainage of Florida; the Nicaragua Canal; Maps and Map Drawing; Glacial Phenomena; and Standard Time. There are others of almost equal interest, making a number fully up to the standard.

The latest number of the PROCEEDINGS of the United States Naval Institute has articles on the Driggs-Schroeder Rapid-fire Gun; Organization of Naval Engineer Forces; the Signal Question; Statics of Launching; Literature of Explosives; and a variety of professional notes of interest.

The JOURNAL of the Military Service Institution for May has a continuation of General Tidball's paper on Artillery in the Rebellion, and articles on the Military Geography of Canada; a Plea for the Colors; Diseases Epidemic in Armies; Post Schools; and several reprints and translations from foreign sources.

The JOURNAL of the New England Water-Works Association for June has much to interest the engineer, including a series of short "Experience Papers" on various questions arising in connection with water-works management.

The April number of the LEHIGH QUARTERLY has articles on Water Cooling Appliances at a Blast Furnace, by F. S. Du Pont Thompson; Boiler Waters and Incrustation, by Alban Eavenson; Manufacture of Heavy Ordnance and Armor Plate, by R. R. Hillman; the Durham Mines, by Heber Denman; and the Theory of Centrifugal Ventilating Fans, by John T. Hoover.

BOOKS RECEIVED.

Transactions of the American Institute of Electrical Engineers. March: Lightning Arresters and the Discovery of Non-Arcing Metals. April: Methods of Electrically Controlling Street Car Motors. Published by the Institute, New York.

Census of Canada, 1891. *Bulletin No. IX: Religions.* Department of Agriculture, Ottawa, Canada.

Quarterly Report of the Bureau of Statistics, Treasury Department, Relative to the Imports, Exports, Immigration and Navigation of the United States for the Three Months Ending December 31, 1891. S. G. Brock, Chief of Bureau. Government Printing Office, Washington.

Wreck Chart of the Great Lakes; Showing the Location of Wrecks from Founderings, Gales of Wind, Fogs and General Stormy Weather Conditions from 1886 *to* 1891. United States Department of Agriculture, Weather Bureau. Washington.

Selected Papers of the Institution of Civil Engineers. Published by the Institution, London, England. The present instalment of these papers includes Rochemont on Portland Cements at Havre; Michaelis on Portland Cement in Sea Water; Bamber & Carey on Portland Cement; Smith on Portland

Cement Concrete; Matthews on the Southampton Water Works; Gill on the Sale of Water by Meter in Berlin; Beare on Building Stones of Great Britain; Airy on Weighing Machines; Fox on the Hawarden Bridge; Manby on the Arauco Railroad and Bio-bio Bridge.

Report of the Board of State Engineers to the Governor of Louisiana for the two years from April 20, 1890, *to April* 20, 1892. Henry B. Richardson, Chief State Engineer; Sidney F, Lewis, H. B. Thompson, Frank M. Kerr and Arsene Perrilliat, Assistants, New Orleans.

Census of Canaaa, 1891. *Bulletin No. VIII.*; *Manufactures*. Department of Agriculture, Ottowa, Can.

Stadia and Earth-work Tables. Four-place Logarithms, Traverse Table, Natural Functions, Map Projections, etc. By Professor J. B. Johnson. Reprinted from *Theory and Practice of Surveying*. John Wiley & Sons, New York; price, $1.25.

This book is received too late for full review in the present issue.

SOME CURRENT NOTES.

THE preparation of the historical exhibit which the Baltimore & Ohio Company will make at Chicago is under charge of Major J. W. Pangborn. In the course of this work he has found it necessary to consult some of the old employés of the Company, and one day recently he had a remarkable assembly in his office. There were present Mr. Christopher Smith, aged 80, and now a resident of Harper's Ferry, who was a driver on the road when it was first opened with horse-power, a fireman in 1833, an engineer in 1834 on one of the old "grasshoppers," and who completed a half century of work on the road; Joseph York, now of Meadville, Pa., who was a fireman in 1836 and an engineer a year later; Samuel Doubleday, who worked in the little repair shop of the Company in 1830, and who was afterward Foreman of the Winans shops in Baltimore; and William Ijams, who was a blacksmith in the repair shops in 1830 also, and was afterward Foreman of the smith shops in the Winans Works. Mr. Doubleday is now 82 and Mr. Ijams 80 years old, and they are the oldest living employés of the Baltimore & Ohio.

After giving some interesting accounts of their early work on the road, the four old gentlemen took lunch with Major Pangborn; Mr. Mendes Cohen, President of the American Society of Civil Engineers, who worked as an apprentice under Mr. Doubleday, was also present.

IN preparing this Baltimore & Ohio historical exhibit Major Pangborn has collected proofs which incline him to make the claim that the Baltimore & Ohio is not only the oldest railroad in the world, but the only one of the pioneer roads retaining its original name, and having existed from the beginning under a continuous succession of management. He claims that before the first meeting held in Baltimore, February 12, 1827, there had been no intention of building a railroad anywhere other than a tramway for quarry or mining purposes. The Stockton & Darlington line, which was established in 1825 and is usually considered the first railroad, was simply a tramway, the whole equipment of which consisted of wagons for carrying coal. It gave no other service to the public, and contractors were permitted to haul their own cars with their own horses over the road as on an ordinary turnpike road. The Liverpool & Manchester Railroad, the first railroad in our present sense of the word in Europe, was opened in 1830, but not until six months after the first section of the Baltimore & Ohio was opened to the public. The first actual work done on the construction of the Baltimore & Ohio, it will be remembered, was on July 4, 1828, when ground was broken in Baltimore.

The first tramway in this country was the Leiper road, which was built in Pennsylvania in 1809, and was used for hauling ore from a mine, but it was only 186 ft. long. A similar road a mile long was built in Delaware County, Pa., a few years later, to carry stone, and in 1827 the well-known tramway three miles in length at Quincy, Mass., was built, also for the purpose of carrying stone from a quarry.

THE official journal of the Ministry of Finance—*The Messenger of Finance, Industry and Trade*—gives the following figures concerning the operations of the Russian State Railroads in the years 1890 and 1891. The figures are given in roubles, except in the third column, where the reduction is made to dollars:

1890.	Total.	Per verst.	Per mile.
Gross revenue	72,508.516 rou.	7,451 rou.	$5,590
Expenses	45,406,209 "	4,666 "	$3,500
Net revenue	27,102,307 "	2,785 "	$2,090
1891.			
Gross revenue	78,130,258 "	7,864 "	$5,900
Expenses	46,023,232 "	4,632 "	$3,475
Net revenue	32,107,026 "	3,232 "	$2,425

The great increase of gross revenue without a corresponding increase of expense led to the very large increase of the net earnings. In the year 1891 the cars ran 2,128,197,-475 axle-versts, or 37,768,170 train versts more than in the year 1890.

The general increase of railroad operations was caused by the development of freight traffic, a result of the government control of the freight tariffs.

CHANGES of gauge have not been as frequent in England as in this country, but the greatest work of the kind ever done in Great Britain has just been completed. The Great Western Railroad, as is well known, was built under the charge of the late Mr. Brunel, with a gauge of 7 ft., the widest ever adopted for an ordinary railroad. Years ago it became apparent that this must be abandoned, and for some time preparations have been in progress for the change. In fact, a large part of the Company's system has been practically of the standard gauge for several years, a number of the branch lines being of that gauge, while on the main line from London to Exeter a third rail of standard gauge has been laid for several years. Last year it was resolved to make the final change, and since then everything has been done to prepare for it. There remained at the last some 200 miles of road—somewhat over 300 miles of track—and the work on this was done on Saturday, May 21, and Sunday, May 22. On these days all regular trains were suspended, and a force of 5,000 men gathered from all the Company's lines was in readiness to move the rails. The work was successfully accomplished, and on Monday, May 23, standard-gauge trains were running over all the Company's lines.

Where the road had been laid on ties in the ordinary way, a third rail was put down beforehand, but a considerable portion of the old line had the rails laid on longitudinal sleepers, and here it required more time and work to make the change.

The Company had still in use about 4,000 cars and a number of locomotives of the 7-ft. gauge. These were all taken before the change to the shops at Swindon, the last of them reaching there May 21. Extra sidings had been prepared for them and the work of changing the gauge of those that are considered worth it was at once begun. Most of the cars will be changed, but a number of the old locomotives will be broken up. The cost of altering the gauge has been considerable, some of the junctions and yards requiring a number of expensive changes.

OUR electrical friends showed an extraordinary variation in their estimates of the cost of providing light for the Columbian Exposition, the highest bid being more than four times the amount of the lowest. There has been quite a sharp contest over the award, but it is stated that the contract has been finally given to the Westinghouse Electric & Manufacturing Company, of Pittsburgh, which agrees to install 92,622 lamps, alternating current, for $399,000. The highest bid named $1,713,567 as the amount for the entire work.

THE June report of the blast furnaces, as given by the *American Manufacturer*, shows a further decrease in production, giving 263 furnaces in blast, with a weekly capacity of 172,890 tons; an increase of one furnace in number, but a decrease of 2,453 tons in capacity. The change is due to the blowing out of six anthracite and coke furnaces of large size, and the starting up of seven small charcoal furnaces. The stocks of pig iron are not increasing.

As compared with June, 1891, the report shows a decrease of four in the number of furnaces in blast, but an increase of 25,091 tons—17 per cent.—in the average weekly production of pig iron.

THERE are conflicting accounts as to the recently reported discoveries of coal in the Argentine Republic. The coal which has been taken out and submitted for analysis is, according to the chemist, "lignite of the tertiary period," of fair quality. A small quantity burned in a locomotive on the Great Western Railroad gave good results. So far only a few outcroppings seem to have been found, and no vein of workable size has been developed. It is also a fact that no proper examination has yet been made, and it is very possible that an exploration by miners of experience might show deposits well worth working. The outcroppings at San Rafael are 150 miles from the nearest railroad station, at Mendoza; but a railroad is proposed, and could be quickly built. San Rafael is near the eastern foot of the Andes, and the mines are on the first range of the Cordillera, at a considerable elevation. It is said they are well placed for easy working by drifts and tunnels, and for easy drainage.

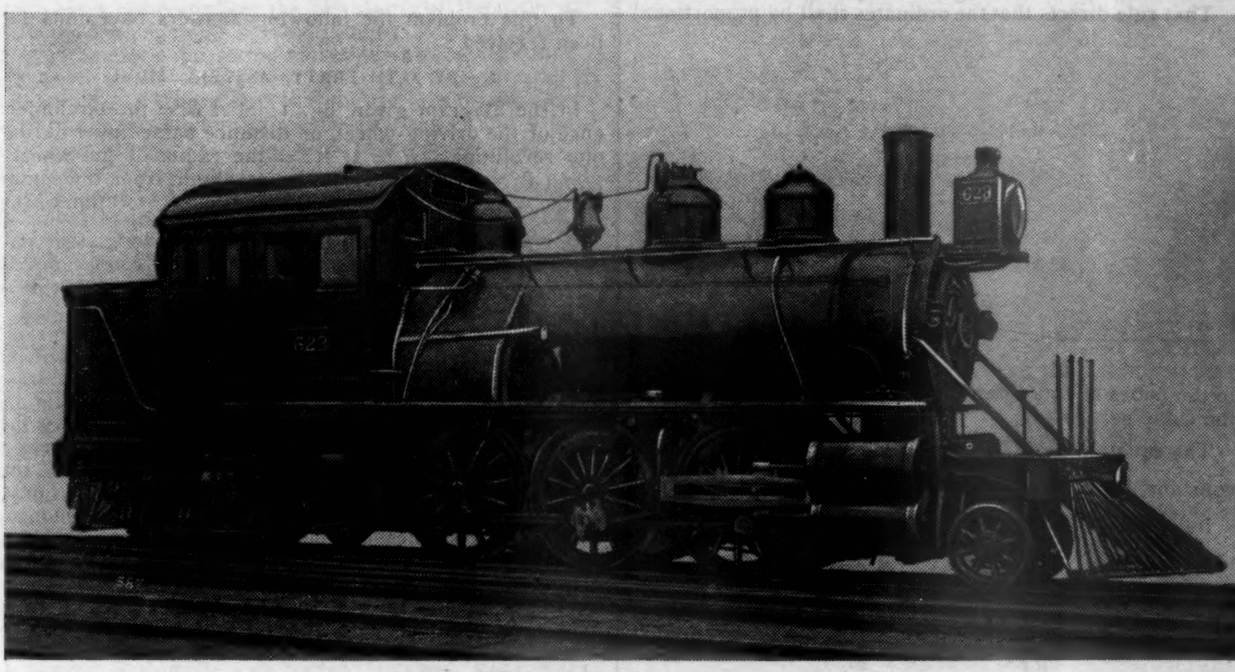
The importance of a discovery of good coal may be estimated when it is stated that English coal costs $10 gold—about $30 to $33 currency—in Buenos Ayres, and all the way from $10 up to $20 gold in the interior, according to the distance from the coast. The lack of fuel has been a great obstacle to the establishment of manufactures, and a drawback to material progress in many ways.

JUST at present no English capital is going to the Argentine Republic, for obvious reasons, and there is not at all a friendly feeling toward the English, who are accused, rightly or wrongly, of increasing and intensifying by their course the financial troubles of the country. There is, on the other hand, a very friendly feeling toward the United States, and an opportunity for the development of trade is presented which Americans ought not to be slow in taking advantage of. The introduction of some American methods on the railroads would be beneficial to both countries.

A COMPOUND SUBURBAN LOCOMOTIVE.

THE accompanying engraving is from a photograph of a locomotive for suburban traffic, designed by Mr. L. B. Paxson, Superintendent of Motive Power of the Philadelphia & Reading Railroad, and built by the Baldwin Locomotive Works in Philadelphia.

The general design is similar to that of the New York Central suburban engine illustrated in the JOURNAL for September, 1891. Both have a two-wheeled truck forward, six coupled drivers and a six-wheeled truck under the rear end of the frames, on which the tank is carried. The present engine differs from the New York Central locomotive referred to in two important points; it is a four-cylinder compound of the Vauclain type, and it has a Wootten fire-box.



COMPOUND LOCOMOTIVE FOR SUBURBAN TRAFFIC.

BUILT BY THE BALDWIN LOCOMOTIVE WORKS, PHILADELPHIA.

The boiler of this engine is 60 in. in diameter and has 321 tubes $1\frac{1}{4}$ in. in diameter and 9 ft. long. The fire-box is 114 × 80 in., and varies from $41\frac{1}{2}$ to $38\frac{3}{4}$ in. in depth. The usual working pressure is 175 lbs.

The high-pressure cylinders are 12 in. and the low-pressure 20 in. in diameter, with 24 in. stroke. The high-pressure cylinders are placed below, and the guides are of the four-bar pattern. The valve motion is of the usual type used with the Vauclain cylinders. The ratio of the cylinders is 1 : 2.8.

The driving-wheels are $61\frac{1}{2}$ in. in diameter. The middle or main pair of drivers has plain tires. The driving-wheels are spaced 5 ft. 6 in. apart; the total driving or rigid wheel-base is 11 ft., and the total wheel-base of the engine is 35 ft.

In order to secure more room the tank is carried forward under the cab. The tank capacity is 2,000 gallons. The cab is placed at the rear end and not over the boiler, as is very commonly done with a Wootten boiler. The engineer and fireman are thus kept together, which is an arrangement much to be preferred to that which leaves one man alone in the cab.

The total weight of this engine in working order is 158,000 lbs., of which 91,000 lbs. are carried on the driving-wheels. It may be noted that the front truck is equalized with all the drivers.

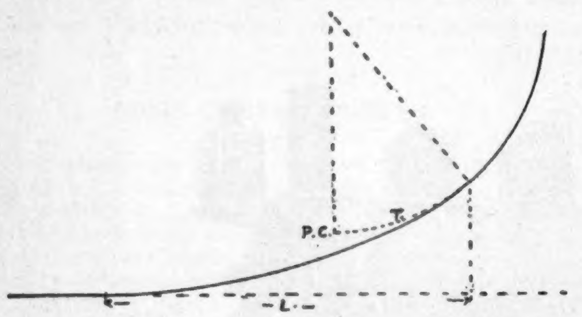
The engine has the Westinghouse automatic brake, including driver brakes. Although built for the Philadelphia & Reading, the engine shown in the photograph has been for some time in use on the Illinois Central, running suburban trains out of Chicago. Its use there has been experimental, to test the use of waste anthracite for the possible reduction of smoke.

TRANSITION CURVES—CORRECTIONS.

To the Editor of The Railroad and Engineering Journal:

I SEND you an examination of the "Short Rule for Transition Curves," published in the JOURNAL of April, 1892. In this reference is made to figure and notation therein employed. The figure is reprinted herewith.

That rule directs that the ordinates shall be proportional



to the cubes of the abscissæ; in other words, that we use the cubic parabola.

The equation of this curve is: $y = kx^3$ (1) where k is a constant. Its total curvature, $\overset{-1}{tan.} \frac{dy}{dx} = \overset{-1}{tan.} (3\,kx^2)$. (2)

Its radius of curvature,

$$\frac{\left[1 + \frac{dy^2}{dx^2}\right]^{\frac{3}{2}}}{\frac{d^2y}{dx^2}} = \frac{[1 + 9\,k^2x^4]^{\frac{3}{2}}}{6\,kx}. \qquad (3)$$

When $y = O$ (4), then by "short rule" $x = \frac{O \times 17000}{D\,T}$. (5)

Substituting (4) and (5) in (1) gives $k = \frac{D^3\,T^3}{O^2\;17000^3}$. (6)

Substituting (5) and (6) in (2) and (3) gives for Mr. Ward's curve:

$$\text{Total curvature} = \overset{-1}{tan.} \frac{3\,D\,T}{17000} \quad (7) \text{ and}$$

$$\left.\begin{matrix}\text{Radius of curvature}\\ \text{at its terminus}\end{matrix}\right\} = \frac{O\left[1 + 9\left(\frac{D\,T}{17000}\right)^2\right]^{\frac{3}{2}}}{6\left(\frac{D\,T}{17000}\right)^2}. \qquad (8)$$

Now, suppose we offset P. C. "to any extent," say 70.77 ft., and run in a 10° curve; then measure from P. C. "to any point," say 50° or 500 ft., and measure ordinate O, which will be 275.44 ft. Now substitute $D = 10$, $T = 500$ and $O = 275.44$ in (7) and (8), and we have for the case before us:

Total curvature = 41° 25′ 25″, instead of 50°, and radius of curvature = 1258.74 ft, corresponding to a curve of 4° 33′ 07″ instead of 10°. In this case, then, we have at the union of the two curves a *jump* of 5° 26′ 53″ in *degree of curve* and a *break* of 8° 34′ 35″ in *direction*. Evidently this "short rule" has not that wide application that its wording would seem to indicate, and it might be well to add another to hold the young engineer within the limits beyond which it is *not* "sufficiently correct." The *Transactions* of the Technical Society of the Pacific Coast contains the curve that is not hampered by limit of application, and which is *exactly* correct.

IRVINGTON, CAL. D. E. HUGHES.

A LOCOMOTIVE PROBLEM.

IN the RAILROAD AND ENGINEERING JOURNAL for April last there was given the following

PROBLEM.

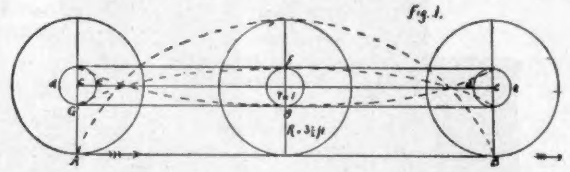
Let it be supposed that the stroke of the pistons of a locomotive is 2 ft., the diameter of the driving-wheels 7 ft. and the speed 60 miles per hour; what is the maximum and minimum velocity of the piston relatively to the earth, and not with regard to the locomotive, and when does each occur?

To this problem the following answers have thus far been received:

I.—BY SETH PRATT, ASSYRIA, MICH.

In the diagram given, fig. 1, let $A\,B$ = the circumference of the driving-wheel, or distance passed over during one revolution. $R = 3\frac{1}{2}$ ft. = the radius of the wheel; $r = 1$ ft. = the distance of the crank-pin from the center of the wheel. A point at G during one revolution of the

Fig. 1.



driving-wheel will describe two cycloids, one above the center line $C\,C$ and the other below it; each having a height of 2 ft. and base equal to the circumference of the wheel. When the crank-pin is at the dead points d or e, the velocity of the piston will be equal to that of the locomotive, or 60 miles per hour. When one-quarter of a revolution is made and the pin is at f, its motion will be direct and we have $R : R + r :: 60$ miles : $77\frac{1}{7}$ miles = the maximum velocity of the piston. When three-quarters of a revolution is made and the pin is at g, we have $R : R - r :: 60$ miles : $42\frac{6}{7}$ miles = the minimum velocity of the piston.

II.—BY D. E. HUGHES, IRVINGTON, CAL.

It is evident that the crank-pin has the greatest *horizontal* movement, relatively to the *locomotive*, when it is at the *highest* and *lowest* points, and that at the *instant* of passing these points the *consecutive* positions of the connecting-rod are parallel. Hence at these times the velocity of the piston is *equal* to that of the crank-pin, or *maximum;* which in this example, where the diameter of the crank-pin's path is 2 ft. and that of the wheel is 7 ft., is $\frac{9}{7}$ of 60 miles per hour. Hence the maximum velocity of piston relative to *ground* is $\frac{9}{7}$ of 60 and the minimum is $\frac{5}{7}$ of 60.

To look at this last point another way: the *bottom* of the wheel is *still*, its axle, $3\frac{1}{2}$ ft. above, has the velocity of the train; then points $2\frac{1}{2}$ and $4\frac{1}{2}$ ft. above the bottom move forward with $\frac{5}{7}$ and $\frac{9}{7}$ of 60 miles, or $42\frac{6}{7}$ and $77\frac{1}{7}$.

III.—BY W. H. TRETHEWEY, STRATFORD, ONT.

Of this problem I beg to submit to you the following solution: At 60 miles per hour the locomotive is moving with a velocity of 5,280 ft. per minute, or 88 ft. per second. The number of revolutions that the driving-wheels will make in any given time = the quotient of the circumference of the driving-wheels into the distance the locomotive moves in that time. Calling the circumference of the 7-ft. wheels 22 ft., which is within $\frac{1}{8}$ in. of the closest mathematical approximation, we find that the driving-wheels make exactly four revolutions per second, or one revolution per quarter second. For each revolution of the driving-wheels the pistons must travel two strokes—a forward and a backward—or 4 ft. per quarter second, or 16 ft. per second, which is the mean velocity of the piston with regard

to the locomotive, not with regard to the earth. But the velocity of the piston is a constantly varying quantity.

In the circle, *A B C D E F*, fig. 2, which represents the path of the center of the crank-pin, *A D* = the piston stroke. As the driving-wheels move with uniform velocity, the crank-pin will move from *A* to *B*, from *B* to *C*, and from *C* to *D* in equal periods of time. But while the crank-pin moves from *A* to *B* the piston moves only the

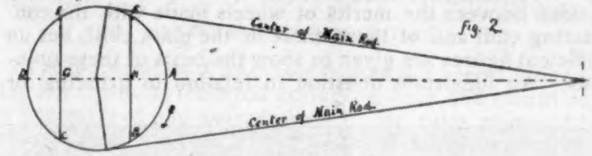


Fig. 2.

distance from *A* to *H*, and while the crank-pin moves from *C* to *D* the piston moves only the distance from *G* to *D*, in these cases not regarding the angularity of the main rod. Now the distance *A H* + the distance *G D* = the distance *H G*; therefore the piston moves one-half of its stroke—viz., from *H* to *G*—in one-third of the time it requires for its full stroke. We have seen that the piston's mean velocity is 16 ft. per second, but its velocity between *H* and *G* must be at the rate of 8 ft. in one-third of a second, or 24 ft. in one second.

This, however, is not the piston's maximum velocity. It moves at its maximum velocity at the instant, and at that instant only, when the center line of the main rod becomes tangent to the crank-pin circle, and its velocity at this instant is the velocity of the crank-pin circle.

Bearing in mind that the circumferences of circles are to each other as their radii, and that the 7-ft. circle of the driving-wheels moved 88 ft. per second, we have the proportion $3\frac{1}{2} : 1 :: 88 : 25\frac{1}{7}$—that is, the velocity of the crank-pin circle, which is the maximum velocity of the piston, is $25\frac{1}{7}$ ft. per second with regard to the locomotive. Relatively to the earth, the piston's maximum velocity will be the velocity of the locomotive plus its own velocity in the cylinder, or $88 + 25\frac{1}{7} = 113\frac{1}{7}$ ft. per second, and its minimum velocity will be the velocity of the locomotive minus its own velocity in the cylinder, or $88 - 25\frac{1}{7} = 62\frac{6}{7}$ ft. per second, and these velocities will occur when the center line of the main rod is tangent to the crank-pin circle during the forward and backward strokes respectively of the piston.

IV.—BY J. B. LEEPER, LAFAYETTE COLLEGE, EASTON, PA.

Having noticed in your JOURNAL for April the problem given above, I was somewhat interested, and give the following as my result:

In fig. 3, let *A D E* represent the path of the crank-pin, *R* the length of crank-arm, and *l* the length of connecting-rod. The motion of the crank-pin can be resolved into two motions, one horizontal, the other vertical. Since the cross-head is fixed in the line *c x*, the vertical motion

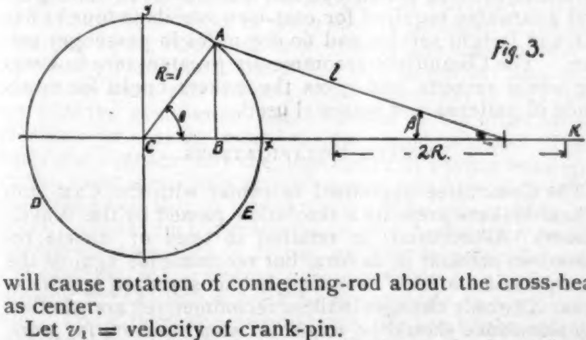


Fig. 3.

will cause rotation of connecting-rod about the cross-head as center.

Let v_1 = velocity of crank-pin.

Let v_2 = velocity of cross-head due to horizontal motion of crank-pin.

Let v_3 = velocity of cross-head due to vertical motion of crank-pin.

Let v = velocity of crank-pin in a vertical direction.

Let the angles be represented as lettered. Then v will constantly decrease from x to y, or the acceleration will be minus and vary as the distance of crank-pin from line $c\ x$.

Let a represent acceleration

Let s represent distance from line $c\ x$.

$$a = \frac{d^2 s}{d t^2} = -b s, \text{ where } b \text{ is some constant}$$

$$\int \frac{d^2 s}{d t^2} d s = -b \int s\, d s$$

$$\frac{d s^2}{d t^2} = v^2 = -b s^2 + c_1$$

when $s = R,\ v = o$

$$c_1 = b R^2$$

$$v^2 = -b s^2 + b R^2 = b (R^2 - s^2)$$

$$v = b^{\frac{1}{2}} (1 - s^2)^{\frac{1}{2}} = b^{\frac{1}{2}} \cos.\ \theta \ (R = 1)$$

when $s = o,\ v = v_1 = b^{\frac{1}{2}}$

$$b = v_1^2$$

$$v = b^{\frac{1}{2}} \cos.\ \theta = v_1 \cos.\ \theta$$

In same way prove

$$v_2 = v_1 \sin.\ \theta$$

$$v_2 + v_3 = \text{velocity of cross-head.}$$

$$v_3 = \sin.\ \beta\, v = \frac{\sin.\ \theta}{l} v_1 \cos.\ \theta$$

Let $u = v_2 + v_3$

$$u = v_1 \left[\frac{\sin.\ \theta \cos.\ \theta}{l} + \sin.\ \theta\right]$$

$$\frac{d u}{d \theta} = v_1 \left[\frac{\cos.^2 \theta - \sin.^2 \theta}{l} + \cos.\ \theta\right]$$

Now, by putting this first derivative equal to o will give the maximum velocity of cross-head,

$$v_1 \left[\frac{\cos.^2 \theta - \sin.^2 \theta}{l} + \cos.\ \theta\right] = o$$

$$\cos.^2 \theta - \sin.^2 \theta + l \cos.\ \theta = o,$$

which formula will give, by substituting in it the value of l, the angle θ at which the piston has its maximum velocity.

As there is no length given for l, I take it equal to 8 ft., and find the maximum to occur when θ is equal to 83° 1′ 52″ to five decimals.

From conditions of the problem,

$$v_1 = 25.14 \text{ ft. per sec.}$$

$$\sin.\ \theta = 0.9926 \text{ ft.}$$

$$\cos.\ \theta = 0.12133 \text{ ft.}$$

Then from formula

$$u = v_1 \left[\frac{\sin.\ \theta \cos.\ \theta}{l} + \sin.\ \theta\right]$$

$$u = 25.33 \text{ ft. per sec.}$$

When piston is moving *with* train, velocity with respect to the earth will be a maximum and will equal 88 + 25.33 = 113.33 ft. per second; also the minimum will occur when piston is moving *opposite* to motion of train, and the minimum velocity = 88 − 25.33 = 62.67 ft. per second.

Let $\theta_1 = 83° 1' 52''$

$$\beta_1 = \frac{\sin.\ \theta_1}{8}$$

Then ver. θ_1 + ver. β_1 = distance of cross-head from k in fig. 3, from which get the position of piston for maximum velocity.

THE CRUISER "CHICAGO."

THE illustration given herewith is from an excellent photograph of the cruiser *Chicago* of the United States Navy. This vessel was the first of the large cruisers of modern type built for the Navy, and is one of the best known, as she has been attached to the White Squadron as flag-ship and has visited many ports along the coast. In this service she has shown herself an excellent and ser-

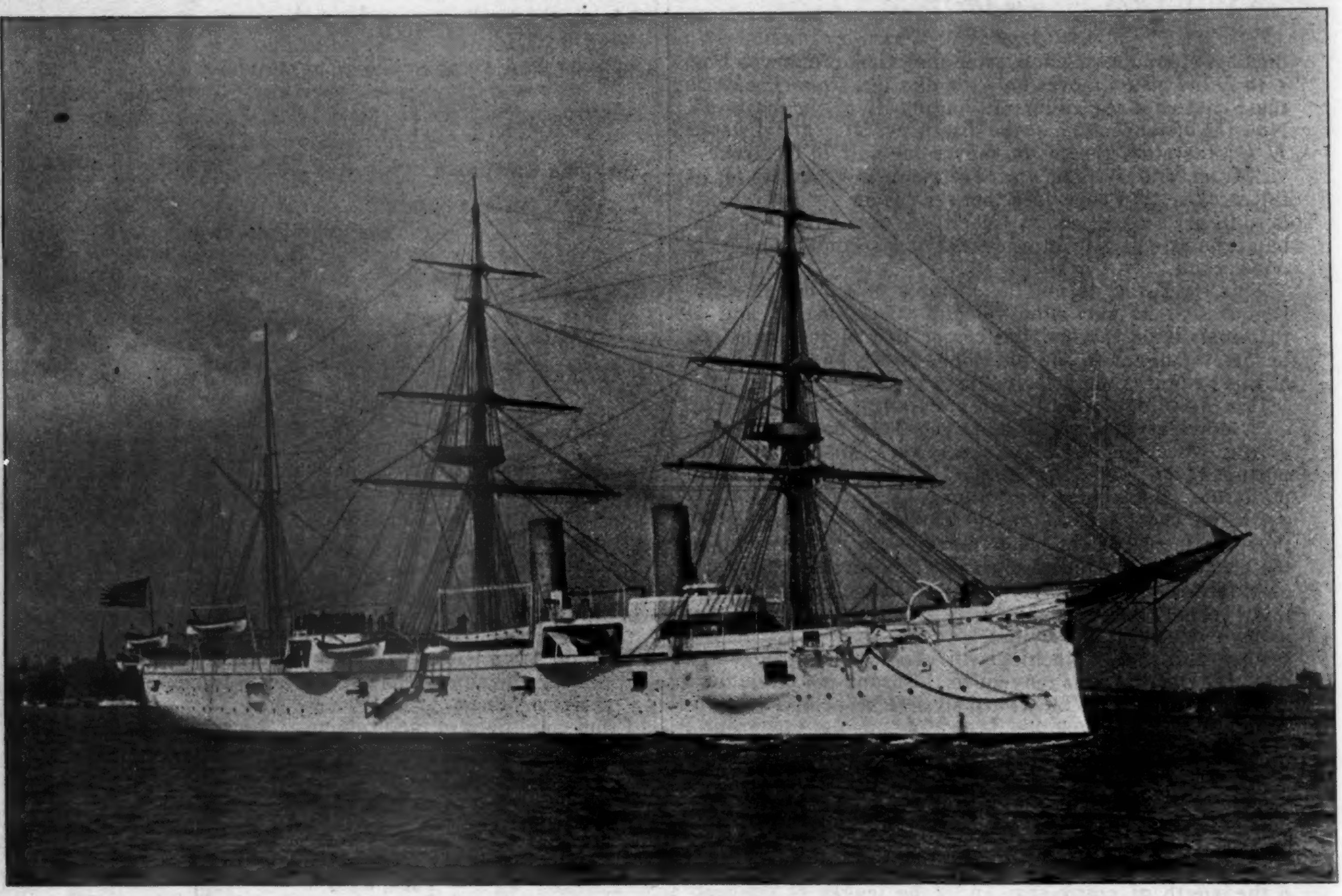
viceable vessel, and her handsome proportions have been generally admired.

The *Chicago* was built at the Roach yards in Chester, Pa. She is an unarmored steel cruiser, with protective deck, and is 315 ft. long, 48 ft. 2 in. beam, 19 ft. mean draft, and 4,500 tons displacement. She has three masts, and is bark-rigged, carrying more sail than most of the new cruisers.

She has twin screws driven by compound engines, and her recorded speed is 15 knots an hour. Her coal capacity is 940 tons, and on that supply the cruising range is 6,000 knots at a 10-knot speed.

The main battery consists of four 8-in., eight 6-in. and two 5-in. breech-loading rifles, and the secondary battery includes 12 small rapid-fire and machine guns.

At the present writing the *Chicago* is at the New York Navy Yard refitting, having just returned from a cruise in the South Atlantic and along the coast of South America.



CRUISER "CHICAGO," UNITED STATES NAVY.

MASTER CAR-BUILDERS' ASSOCIATION REPORTS.

THERE is given below a brief summary of the principal committee reports presented to the Master Car-Builders' Association at the Convention in Saratoga. The disposition made of these will be found in the proceedings of the Convention, on another page.

STEEL-TIRED WHEELS.

The Committee on Steel-Tired Wheels makes a brief report, stating that returns have been received from roads owning over one-third of the passenger cars in the country, and that these roads have some 25,000 steel-tired wheels in use of different patterns, the Allen, which was the earliest used, predominating. Most of the defects stated in the report relate to the tires and not to the centers, but some trouble from loose bolts is reported where bolted centers are used.

CAST-IRON WHEELS.

The Committee on Cast-Iron Wheels quotes a number of answers returned by different roads to questions about them. From these it appears that opinion is about equally divided between the merits of wheels made with the contracting chill and of those made in the plain chill, but no sufficient figures are given to show the basis of these opinions. An important question in relation to grinding or balancing wheels called out but few answers. The general guarantee required for cast-iron wheels is four to five years in freight service and 60,000 miles in passenger service. The Committee recommends greater care in keeping wheel records, and gives the makers credit for excellence of patterns and material used.

WHEEL SPECIFICATIONS.

The Committee appointed to confer with the Cast-Iron Wheel-Makers presents a resolution passed by the Wheel-Makers' Association, in relation to tests of wheels removed on account of failure, but recommends against the incorporation of this condition in the standard specifications. The only changes in these recommended are whether any allowance should be made to wheel-makers for worn flanges, with some slight changes in the wording in order to make the conditions somewhat more definite than they are at present.

FREIGHT CAR TRUCKS.

The Committee on Freight Car Truck Frames make a very brief report, recommending that the investigation be continued, as sufficient data have not been collected to make a full report.

JOINT INSPECTION.

The Committee on Joint Inspection recommends a number of minor changes in the rules, especially in those relating to defects and breakages in standard couplers, and in brake-shoes. The changes are chiefly in the wording, the object being to make the rules clearer and more distinct and to afford fewer opportunities for dispute.

ARBITRATION AND RULES.

The Arbitration Committee presents a report embodying the decisions rendered during the year, and also giving a summary of the amendments to the rules proposed by the different railroad clubs, some of which are recommended for adoption and others are not. It is impossible here to give these in full, as they mostly relate to the wording of the rules, and the changes adopted appear in the report of the meeting.

AIR-BRAKE AND SIGNAL INSTRUCTIONS.

The Committee on Air-Brake and Signal Instructions presents a long and carefully prepared report, giving in full an amended code of instructions with respect to the air-brake for trainmen, repair shops, and inspectors. The principal point upon which the report dwells, in commenting upon the amendments made, is the limits of stroke of the air-brake piston at the time adjustment of the brakes is made. The Committee urges very strongly adherence to the standards of the Association, and recommends the use of a metallic brake-beam.

STANDARDS OF THE ASSOCIATION.

The Committee on the Standards of the Association reports that careful inquiries have been made, the result not being altogether satisfactory, on account of the failure of members to answer the circulars. A number of standards are generally adopted and complied with, but in others there is considerable variation, especially in two important points, the height of draw-bars and the use and form of dead-blocks. In view of the facts as ascertained, the Committee recommended the abolition of some of the standards, including gauges for testing diameter, flange, bore of wheels and size of journals, and also those for the attachment and dismensions of draw-bars. A careful revision of the other standards is recommended, and an improvement in the method of publishing the standards. They believe that drawings of the various standards should be prepared in such form that they could be used at once for preparing blue prints for shop use.

STANDARDS FOR AIR BRAKES.

THE Committee on Standards of Efficiency for Air Brakes present a series of rules and tests, without recommending their immediate adoption. The object of the rules is chiefly to prevent the adoption of inferior devices and makeshifts. What is presented is intended more as an outline to be improved upon during the coming year. Some of the recommendations are still imperfect and require more work and investigation ; especially is this the case with the graduation test. Several of the other tests have also to receive more careful consideration. The Committee realizes fully the importance of having nothing but the most searching requirements, nor have they lost sight of the fact that in future there will be competition in brakes. Under such circumstances the Association must fully consider whether it is not its duty to prescribe the most exacting requirements now attainable by any brake company, even to that of working successfully on a 100-car train. The Committee recommends the establishment of a permanent testing station.

M. C. B. COUPLER STANDARDS.

This Committee recommends the general adoption and use of the gauges approved by the Executive Committee (illustrated in the JOURNAL for October, 1891, pages 473 and 474). A standard method for operating the locking devices and a more secure fastening than the tail-bolt are recommended. A set of specifications is submitted for approval, or for further trial. The careful testing of a number of standard couplers from different manufacturers is also recommended.

STANDARD CENTER-PLATES AND STAKE-POCKETS.

The Committee on Standard Center-Plates and Stake-Pockets has prepared, in accordance with the instructions given at the last Convention, drawings of standard stake-pockets, which are shown in figs. 1, 2, 3 and 4, given herewith. These show two sizes with single U-bolts and two with double U-bolts, one of each kind for stakes 4 in.

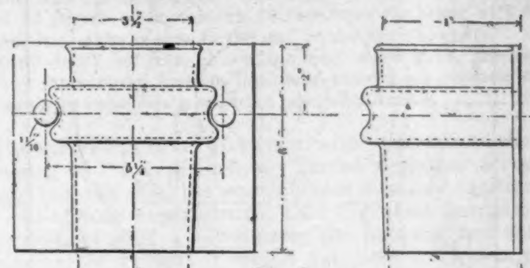


Fig. 1

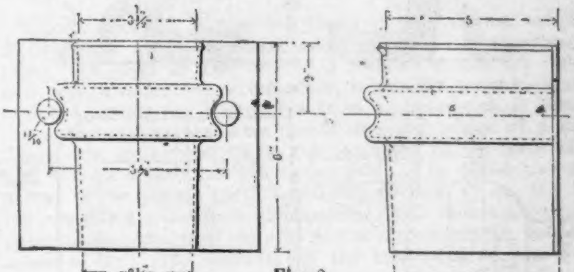


Fig. 2

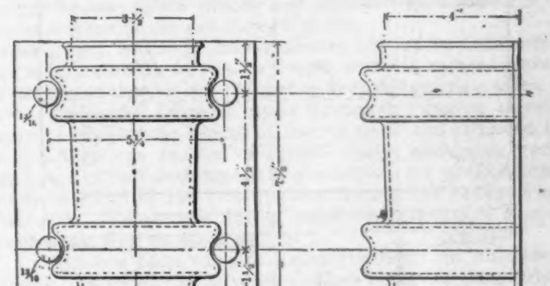


Fig. 3

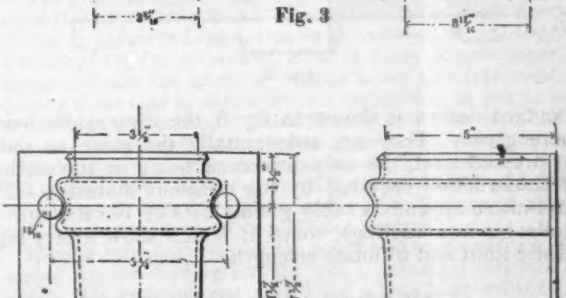


Fig. 4

deep at the top and the other for stakes 5 in. at the top, the width and taper being uniform.

For center-plates fig. 5 shows the standard recommended for pressed steel. The plates are all 14 in. long, the truck center-plate being $11\frac{1}{2}$ in. wide, the body center-plate for

iron bolsters 18 in. wide and for wooden bolsters 12 in., with the holes placed as shown. There being some difference of opinion as whether the plates should have flanges to fit the bolsters, such flanges are not shown in the drawings. For malleable iron center-plates the proposed

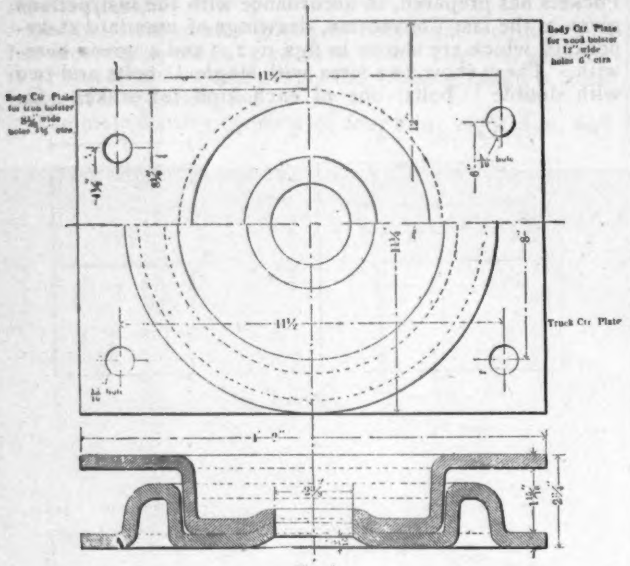


Fig. 5

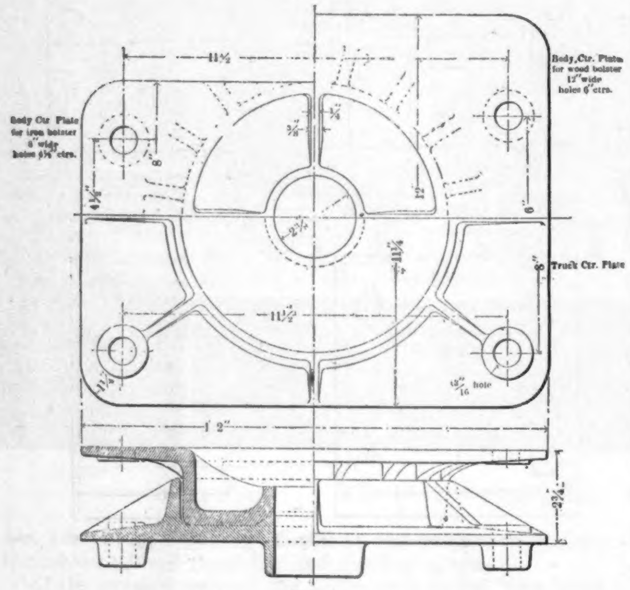


Fig. 6.

standard design is shown in fig. 6, the dimensions being there given. They are substantially the same as those for pressed steel, the only difference being in the method of construction required by the different material. The Committee appends a table giving tests of the strength of malleable iron castings, some of which show a very high elastic limit and ultimate strength.

STEAM HEATING AND VENTILATION.

This Committee reports that there has been a great increase in the number of cars heated by steam, without much change in methods. The great point required is simplicity. The report says that at the present time the various methods of heating cars by steam may be grouped into two classes, known as the direct and indirect, the distinction between the two being as follows: In the direct system steam is supplied directly to radiating pipes in the car. In the indirect system, steam is used to heat water contained in the radiating pipes in the car. The direct system is the cheaper and simpler, but it is not susceptible of as fine regulation as the indirect, although care and attention on the part of the trainmen have given very satisfactory results. The direct system also is inapplicable to cars like sleepers in which the piping is necessarily tortuous, or in cars equipped with Baker or other hot-water heaters, unless a complete additional equipment of radiating pipes is introduced. Various arrangements, some of them quite successful, have been devised for heating the water in the circulating pipes of the Baker heater by steam, leaving the heater itself intact and ready for use, in case the steam supply should fail. It is not considered advisable to make any recommendations nor express any opinion as to the relative merits or efficiency of the different systems, especially as your Committee has no reliable experimental data to present, or to form the basis of an opinion.

The immediate and most important object of this Committee is to consider the points involved in steam heating so far as they affect the matter of interchange of cars having different systems of heating or different steam connections or couplers. With this object in view, the Committee submits and recommends standards for: 1. Location and size of end of steam pipe. 2. 45° elbow for end of steam pipe. 3. Hose nipple. 4. Steam hose. 5. Location of steam coupling.

PROGRESS IN FLYING MACHINES.

By O. Chanute, C.E.

(*Continued from page* 273.)

Two somewhat similar experiments are alluded to in M. G. de la Landelle's "Aviation," published in 1863, but are too briefly described to give much of an idea as to the kind of apparatus employed; he says:

Paul Guidotti, an artist-painter, sculptor and architect, who was born in Lucca in 1569, constructed wings of whalebone covered with feathers, and made use of them several times with success. Determining to exhibit his discovery, he took flight from an elevation, and sustained himself pretty well in the air for a quarter of a mile, but soon becoming exhausted, he fell upon a roof, and his thigh-bone was broken. . . .

I might also cite the article from the Malaga newspaper, the *Courier of Andalusia*, which was republished in several French journals in March, 1863, stating that a peasant of the neighborhood, named *Francisco Orujo*, was said to have sailed in the air a distance of one league with artificial wings in less than fifteen minutes; but why multiply examples? It is better to deduce from these occurrences, some of which are abundantly authenticated, useful conclusions concerning the insufficiency of man's muscular power, and concerning the sustaining power of an inclined plane.

The writer has been thus far unable to find in other publications fuller accounts of the last two experiments mentioned, but it is a significant fact that the greater number of the experimenters who are said by tradition to have actually succeeded in floating for a short distance on the air, were men living in warm climates, where the soaring varieties of birds are much more numerous and more easily observed than in variable and colder climates. This suggests the inference that these experimenters had been watching the soaring birds, sailing upon fixed wings in every direction, and endeavored to imitate their evolutions. With the aid of the wind they may have attained a glimmer of success, but they failed in every instance for lack of accurate knowledge of what constitutes the science of the birds. Elsewhere than in warm climates the soaring birds are so few, they so frequently have to resort to flapping, that those who have not seen them sailing about for hours upon fixed, extended wings, deny even the possibility of such a performance, and only think of wings as oscillating surfaces; and so when, in 1842, *Henson* patented his flying machine, the proposal to obtain support from the fixed surfaces of an aeroplane was hailed by many as a new and happy idea.

A top view of *Henson's* apparatus is shown by fig. 37. It consisted of an aeroplane of canvas or oiled silk stretched upon a frame made rigid by trussing, both above and below. Under this surface a car was to be attached

containing a steam-engine, its supplies and the passengers. The apparatus was to be propelled by two rotating wheels, acting upon the air after the manner of a windmill. Back of these was a tail, also covered with canvas

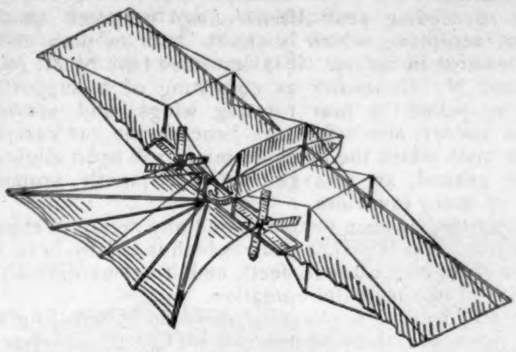


Fig. 37.—HENSON—1842.

or oiled silk, stretched upon a triangular frame, and capable of being expanded or contracted at pleasure, or moved up and down for the purpose of causing the machine to ascend or to descend. Under the tail a rudder was placed for steering the machine to the right or to the left, and above the main aeroplane a sail or keel-cloth was stretched, as shown, between the two masts which rose from the car, in order to assist in maintaining the course. The apparatus was to sail with its front edge a little raised so as to obtain the required support or lift from the air, and was to be started from the top of an inclined plane, in descending which it was to attain a velocity sufficient to sustain it in its further progress, the steam-engine being only designed to overcome the head resistance when in full flight.

Henson's patent indicates that he believed the correct proportions to be about 2 sq. ft. of supporting surface to each pound of weight, this being considerably in excess of the proportion of the large soaring birds, and that the motor required was about at the rate of 20 H.P. per ton of weight. His general design evidences careful thought and possesses some excellent features, but the form of his aeroplane was crude and its equilibrium especially was deficient. *Henson* stated in his patent:

The following are the dimensions of the machine I am making, and which will weigh about 3,000 lbs. The surface of the planes on either side of the car will measure 4,500 sq. ft., and the tail 1,500 more, with a steam-engine (high pressure) of 25 to 30 H.P.

Scaled from the patent drawings the intended dimensions of the main aeroplane appear to have been about 140 ft. long, in the direction of motion, by about 32 ft. in width, this being considerably larger than the great aeroplane that Mr. Maxim has been lately constructing in England. *Henson* did not realize his intention, for Mr. *F. W. Brearey*, Honorary Secretary of the Aeronautical Society of Great Britain, says in an article upon flying machines, published in *Popular Science Review* in 1869,* in describing the *Henson* experiments:

The fact is the machine was never constructed; for after two abortive attempts to manufacture models at the Adelaide Gallery, which should represent the dimensions before named, he rejoined his friend (*Stringfellow*) at Chard, and the two together commenced their experiments under a variety of forms. . . . However, in 1844, they commenced the construction of a model; *Henson* attending chiefly to the wood or framework and *Stringfellow* to the power, and after many trials adopted steam. This model, completed in 1845, measured 20 ft. from tip to tip of wing, by 3½ ft. wide, giving 70 square feet sustaining surface in the wings, and about 10 ft. more in the tail. The weight of the entire machine was from 25 to 28 lbs. . . . An inclined plane was constructed, down which the machine was to glide, and it was so arranged that the power should be maintained by a steam-engine, working two four-bladed propellers each 3 ft. in diameter at the rate of 300 revolutions per minute.

A tent was erected upon the downs, 2 miles from Chard, and for seven weeks the two experimenters continued their labors. Not, however, without much annoyance from intruders. In the language of Mr. *Stringfellow*: "There stood our aerial *protégé* in all her purity—too delicate, too fragile, too beautiful for this rough world; at least those were my ideas at the time, but little did I think how soon it was to be realized. I soon found, before I had time to introduce the spark, a drooping in the wings, a flagging in all the parts. In less than ten minutes the machine was saturated with wet from a deposit of dew, so that anything like a trial was impossible by night. I did not consider that we could get the silk tight and rigid enough. Indeed the framework was altogether too weak. The steam-engine was the best part. Our want of success was not for want of power or sustaining surface, but for want of proper adaptation of the means to the end of the various parts."

Many trials by day, down inclined wide rails, showed a faulty construction, and its lightness proved an obstacle to its successfully contending with the ground currents.

The above has been given verbatim, because of the importance of the experiments. Stated in plainer terms, it means that the machine was deficient in stable equilibrium for out-of-door experiments; that "ground currents" or little puffs of wind would destroy the balance, and that in falling to the ground it would get more or less injured. That the experimenters, annoyed at the presence of spectators at these mishaps, endeavored to test their machine at night, with still less success, and finally gave it up in disgust. Mr. *Brearey* then continues:

Shortly after this *Henson* left England for America, and Mr. *Stringfellow*, far from discouraged, renewed his experiments alone. In 1846 he commenced a smaller model for indoor trial, and, although very imperfect, it was the most successful of his attempts (an illustration from a photograph is given); the sustaining planes were much like the wings of a bird. They were 10 ft. from tip to tip, feathered at the back edge, and curved a little on the under side. The plane was 2 ft. across at the widest part; sustaining surface, 17 sq. ft.; and the propellers were 16 in. in diameter, with four blades occupying three-quarters of the area of the circumference, set at an angle of 60°. The cylinder of the steam-engine was ¾ in. diameter; length of stroke, 2 in.; bevel gear on crank-shaft, giving 3 revolutions of the propeller to 1 of the engine. The weight of the entire model and engine was 6 lbs., and with water and fuel it did not exceed 6½ lbs.

The room which he had available for the experiments did not measure above 22 yds. in length, and was rather contracted in height, so that he was obliged to keep his starting wires very low. He found, however, upon putting his engine in motion that in one-third the length of its run upon the extended wire, the machine was enabled to sustain itself; and upon reaching the point of self-detachment it gradually rose until it reached the farther end of the room, where there was a canvas fixed to receive it. Frequently during these experiments it rose after leaving the wire as much as 1 in 7.

Stringfellow then went to Cremorne Gardens with the two models, but found the accommodations no better than at home. It was found that the larger model (*Henson's*) would run well upon the wire, but failed to support itself when liberated. Owing to unfulfilled engagements as to room, Mr. *Stringfellow* was preparing for departure, when a party of gentlemen, unconnected with the gardens, begged to see an experiment, and finding them able to appreciate his endeavors, he got up steam pretty high and started the small model down the wire. When it arrived at the spot where it should leave the wire, it appeared to meet with some little obstruction and threatened to come to the ground, but it soon recovered itself and darted off in as fair a flight as it was possible to make, to a distance of about 40 yds., farther than which it could not proceed.

Having now *demonstrated the practicability of making a steam-engine fly*, and finding nothing but a pecuniary loss and little honor, this experimenter rested for a long time satisfied with what he had effected.

It is evident that, taught by experience, Mr. *Stringfellow* had obtained greater stability in the smaller model. The aeroplane was shaped like the wings of a bird, slightly curved on the underside and feathered at the back edge, so that the elastic yielding of the feathers might automatically regulate the fore and aft stability, like the back fold in the paper aeroplane which has been described; but the equilibrium was still insufficient for experiment out-of-doors, and the important problem of safely coming down was not solved at all, for to prevent

* *Popular Science Review*, vol. 8, p. 1.

breakage the apparatus had to be caught in a canvas fixed to receive it.

The sparrow-hawk, whose excursion has been described (fig. 36), solved this last problem by simply tilting himself back and opening his wings wide so as to stop his headway by increased air resistance. This possibly might be done with a full-sized apparatus mounted by an operator, but was scarcely practicable in a small model. To mitigate this difficulty Mr. *Stringfellow* increased the sustaining surface, so that it was 2.61 sq. ft. per pound, and therefore might act like a parachute, but this largely increased the "drift," and required more power, so that water and fuel could only be provided for a very brief flight, and the machine cannot fairly be said to have "demonstrated the practicability of making a steam-engine fly."

Mr. *Stringfellow* took the matter up again in 1868, and made further experiments with a somewhat different apparatus, which will be described in due course.

The next proposal for an aeroplane was that of *Aubaud*, in 1851, which is shown in fig. 38. It provided for a number of supporting planes, above which rotating screws were to furnish ascending power, while vibrating wings

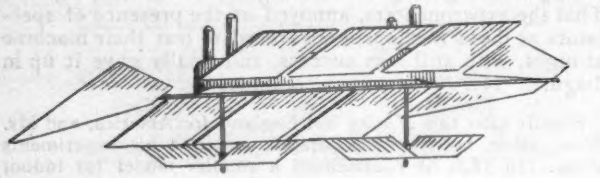


FIG. 38.—AUBAUD—1851.

were to propel. The car containing the motor was to be beneath the planes, and equipped with legs or tubes containing compressed air, in order to ease off the shocks which might be encountered in alighting.

M. *Aubaud* seems to have reasoned that in order to secure safety in coming down, it was necessary to arrange matters so that the whole weight, or nearly the whole weight of the apparatus, could be sustained by screws when about alighting. This same general idea will be found to crop out in a number of subsequent proposals by inventors, who have believed that in order to come down safely it is necessary to design a machine which has enough power to start up by itself on level ground. This, of course, requires much more power than it only horizontal flight is provided for, and handicaps the inventor in an experimental machine.

The writer has been unable to ascertain whether *Aubaud* ever tested his apparatus experimentally. It seems clear that if he did, he must have become aware that no motor then known was sufficiently light in proportion to its energy to raise his machine into the air with screws, especially as he actually increased the ascending resistance by placing planes beneath the screws, so that the latter would not only have to sustain the weight, but also

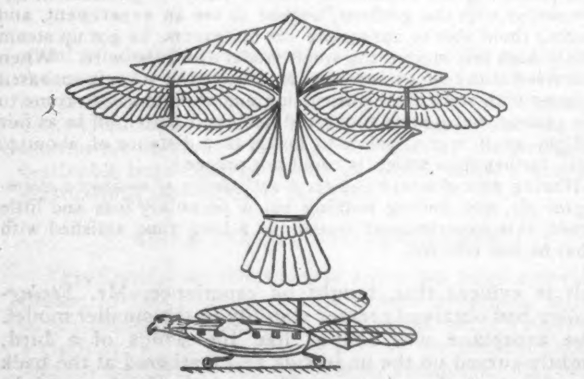


FIG. 39.—LOUP—1852.

to overcome the vertical air pressure resulting from the movement. He advanced a meritorious proposal, however, by dividing the sustaining surface into several planes, an arrangement which we shall find (in describing Mr. *D. S. Brown's* experiments) to add materially to the stability; but even with this feature the apparatus, as shown in the figure, is deficient in equilibrium, and would have come to grief many times if it had been experimented with.

The succeeding year *Michel Loup* proposed another form of aeroplane, which is shown both in plan and in side elevation in fig. 39. It is described both by M. *Dieuaide* and M. *Tissandier* as consisting of a supporting plane propelled by four rotating wings, and provided with a rudder, also with legs beneath the car carrying wheels upon which the machine might roll upon alighting on the ground, an arrangement subsequently proposed again by many inventors.

The writer has been unable to find any record of experiments tried with this apparatus (which is chiefly here figured to show the wheeled feet), and it seems difficult to conceive of its successful operation.

In 1856 *Viscount Carlingford* patented both in England and France the aeroplane shown in fig. 40, and resembling in outline a falcon gliding downward with partially

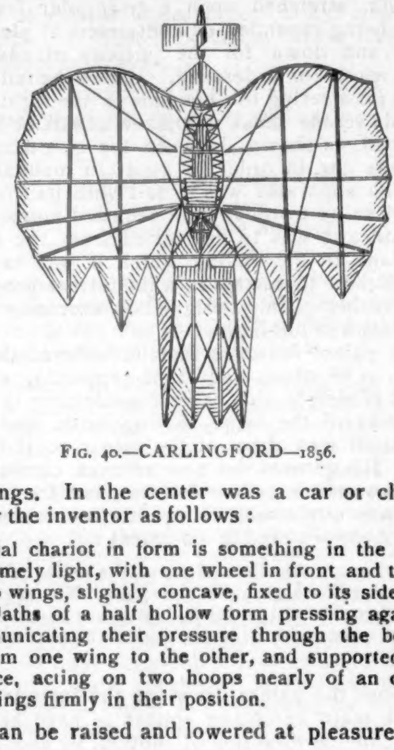


FIG. 40.—CARLINGFORD—1856.

closed wings. In the center was a car or chariot, described by the inventor as follows:

> The aerial chariot in form is something in the shape of a boat, extremely light, with one wheel in front and two behind, having two wings, slightly concave, fixed to its sides, and sustained by laths of a half hollow form pressing against them, and communicating their pressure through the body of the chariot from one wing to the other, and supported by cords, whose force, acting on two hoops nearly of an oval shape, hold the wings firmly in their position.

A tail can be raised and lowered at pleasure by means of a cord.

The chariot is drawn forward by an "aerial screw" in front thereof, "which screws into the air at an elevation of 45°, similar to the bird's wing; and is turned by means of a winch acting on three multiplying wheels." This screw "is known as the Carlingford screw; the blades of this screw become more straight as they approach the center, or, in other words, their edges become more direct toward the center. . . . When a certain altitude is attained the chariot may go several miles, perhaps 50 or 60, as it were, upon an inclined plane of air."

A novelty consisted in the mode proposed for starting the chariot. It was proposed to suspend it by ropes between two poles, and then allow it (by drawing a trigger suddenly) to fall upon the air and to be drawn "forward with great velocity by the falling of the weight in front;" a method which we have seen to have been subsequently adopted by M. *Trouvé* in starting his bird. If the inventor was thoroughly assured beforehand of the stability of his apparatus at all angles of incidence, this would be an elegant method of getting under way, but it would be somewhat awkward if there was any miscalculation about the position of the center of pressure. The writer has found no record of any experiments with the Carlingford apparatus.

(TO BE CONTINUED.)

AN ENGLISH LOCOMOTIVE FOR MIXED TRAFFIC.

THE accompanying illustration, from London *Engineering*, shows a class of locomotives designed by Mr. James Holden, Locomotive Superintendent of the Great Eastern Railway of England; they are used on that road for running the heavy excursion traffic to the seaside resorts in the summer, while in the winter they are used on the market, stock and fast freight trains. About 30 of this class are in use, and 30 more have lately been ordered. The general design, as will be seen, is an inside-connected engine with four coupled drivers and a single pair of leading wheels in front.

The boiler is 52 in. in diameter and has 252 tubes, 1⅝ in. diameter and 10 ft. 4 in. long. The inside fire-box is of copper; it is 63⅞ × 40½ in., and varies in depth from 61½ to 67½ in. The grate area is 18 sq. ft.; the heating surface is: Fire-box, 101; tubes, 1,107; total, 1,208 sq. ft. The smoke-stack has a sectional area of 1.06 sq. ft., the ratio to the grate area being 1 : 16.8.

The main frames are of 1-in. steel plate; the outside frames at the leading end are ⅞ in. thick, welded just forward of the driving axle to a 6 × 3 × ½-in. angle-iron, which carries the running board.

The leading wheels are 48 in. in diameter. The leading axle has both outside and inside journals, the former 6 in. and the latter 8¾ in. in diameter. The inside journals carry most of the weight. A lateral play of 1 in. is given to the journal boxes, to permit the engine to pass freely around curves.

The cylinders are 17½ in. in diameter by 24 in. stroke. The steam ports are 15 × 1½ in. and the exhaust ports 15 × 3¼ in. The valve is of the shifting link type. The valves have ⅞ in. outside lap, and their maximum travel is 3¾ in. The two cylinders are cast in one piece and have the steam-chests below. They are set on an incline of 1 in 8, but the valve faces are horizontal. The crossheads work on single-bar guides. The engine has Macallan's variable exhaust nozzle.

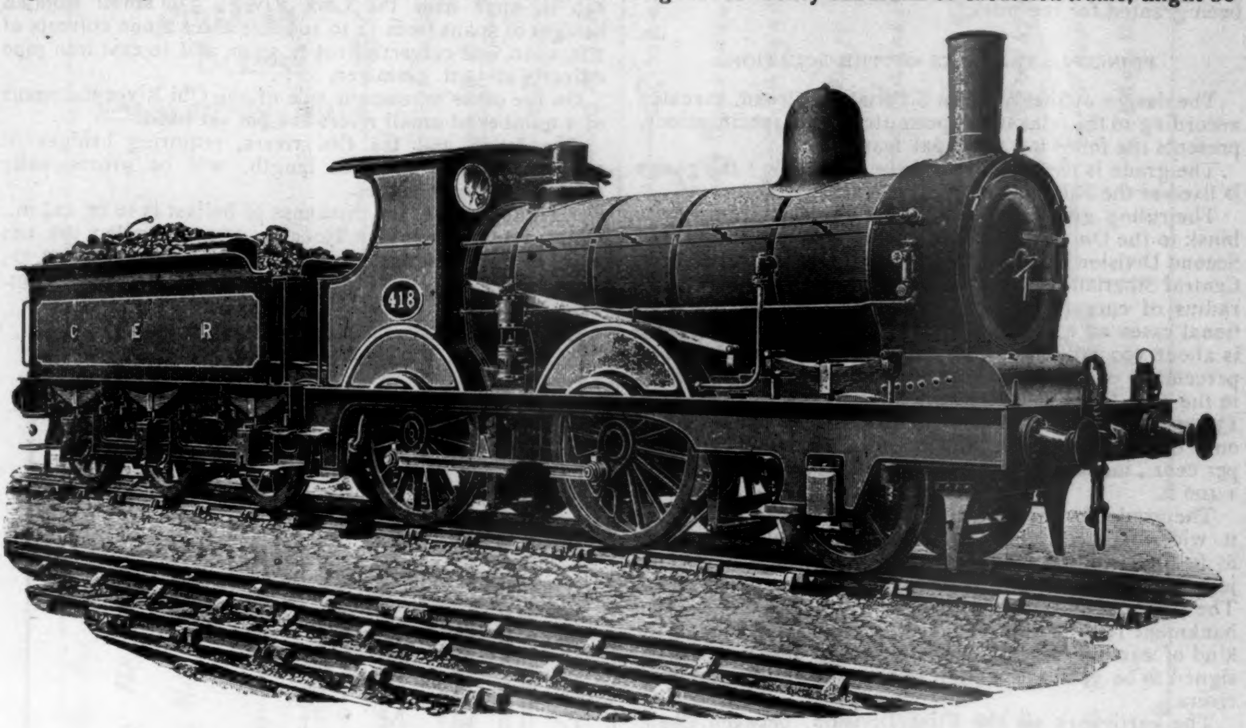
The driving-wheels are 68 in. in diameter. The driving-axles have 7½ × 9-in. journals. The driving-wheel-base is 8 ft. 9 in., and the total wheel-base is 16 ft. 6 in.

The tender is of the usual English type and is carried on six wheels, with outside bearings and a plate frame.

It may be mentioned that cast steel has been used wherever possible in these engines. They are fitted with the Westinghouse brake.

The total weight of the engine in working order is 90,300 lbs., of which 58,600 lbs. are carried on the leading wheels and 31,700 lbs. on the four coupled driving-wheels.

These engines, which are of a type much approved in England for heavy suburban or excursion traffic, might be compared with the Reading suburban engine given on another page.



LOCOMOTIVE FOR MIXED TRAFFIC, GREAT EASTERN RAILWAY, ENGLAND.

THE GOVERNMENT SURVEYS FOR THE GREAT SIBERIAN RAILROAD.

BY A. ZDZIARSKI, C.E.

(*Continued from page 260.*)

IN the first part of this article, in the June number of the JOURNAL, a map showing the location of the road was given; in the present number we give a sketch map of Western Siberia, showing the relative position of the road.

The small diagram shows the profile of the Zlatooust-Chelabinsk Railroad, which really forms the first section of the line, and which extends the Samara-Oufa-Zlatooust line—the connection of the Siberian road with European Russia—to the town of Chelabinsk on the eastern side of the Oural Mountains. This road is now nearly completed, and the starting point for the Western Siberian Railroad will be at Chelabinsk.

The large diagram is a profile of the Western Siberian Railroad as located. It shows first the descent of the eastern slope of the Ourals; then the long level section across the great plateau of Western Siberia, where the only considerable variations from a level are at the crossings of the great rivers—the Tobol, the Ishim and the Irtish—and finally the rise from this plateau into the mountainous region west of Lake Baikal, where the junction with the previously surveyed portion of the Central Siberian line begins.

Since the first part of this article was received, the Committee of Ministers having the matter in charge has decided—April 28/May 10—on the following points:

1. The road is to be built on the location of 1891, which

is shown in our maps and described in the accompanying text, starting from Chelabinsk and passing through Kourhan, Petropavlosk, Omsk, Kainsk, Kolyvan and Pochitanka.

2. The construction of the first section—from Chelabinsk to Omsk—is to be begun during the present year.

3. The road is to be built by the Government directly; for 1892, however, a credit of only 1,100,000 roubles has been granted for the work.

PRINCIPAL FEATURES OF THE LOCATION.

The design of the Western Siberian Railroad, executed according to the relaxations permitted in the specifications, presents the following principal features:

The grade is designed for single track only; the gauge is fixed at the Russian standard of 5 ft.

The ruling gradient for the First Division from Chelabinsk to the Obi River is fixed at 0.6 per cent., and for the Second Division from the Obi River to the connection with Central Siberian Railroad at 0.8 per cent. The minimum radius of curvature is placed at 1,750 ft., and in exceptional cases at 1,400 ft. The total length of level grades is about 500 miles, or 56.5 per cent. of the whole. The percentage of gradients in the direction from Chelabinsk to the Obi River is as follows: Less than 0 5 per cent., 13 per cent. of the whole; and from 0 5 to 0.6 per cent., only 6 per cent. The percentage of curved line is 6.48 per cent., including 0 08 per cent. of curves of a radius of 1,400 ft.

The grade, for single track only, is designed to be 16.45 ft. wide in all cuttings, and in small embankments under 8¾ ft. high, and 18 2 ft. wide on higher embankments subject to shrinkage, and in embankments on marshy ground. The slopes of cuttings are designed to be 1¼, those of embankment 1½, and this could be varied according to the kind of earth. Near the river crossings the grade is designed to be 3½ ft. above high water, and 5 ft. for the great rivers.

The earthwork on the First Division, between Chelabinsk and the Obi River, on 833 miles, consists almost exclusively of small embankments (3 to 4 ft.), and the total estimated quantity is 26,746,000 cubic yards, or about 30,000 cub. yds. per mile. Heavy embankments occur only at the crossings of the rivers Tobol, Ishim, Irtish, Chik and Obi. At the latter there are 380,000 cub. yds. per mile. For the execution of the earthworks it is designed to apply an American machine, the Austin New Era Grader.

A distinguishing feature of the Western Siberian Railroad is an absence of small river crossings required. The line crosses the great rivers Tobol, Ishim, Irtish, Obi and Tomi, but in the intervals between these great rivers there are no secondary thalwegs or valleys, and the soil presents only small local depressions without any well-pronounced slope and watershed.

The great Siberian rivers have this common feature, that they run from south to north, and therefore the ice clears out or breaks up in the upper parts earlier, giving them for a time a great quantity of water.

The time of clearing and freezing of these rivers is the following:

	Time of Clearing.	Time of Freezing.
Tobol at Kurhan......	April 7/19 — 18/30	Oct. 11/23 — Nov. 9/21
Ishim at Petropavlovsk....	April 3/15 — 21/May 3	Oct. 11/23 — Nov. 8/20
Irtish at Omsk...........	April 11/23 — 29/May 11	Oct. 11/23 — Nov. 13/25

The spring high waters run in the Tobol about two weeks, in the Ishim also about the same, and rise to 20 and 28 ft.; in the Irtish they last very long—from May to the end of July—rising to 20 and 25 ft. The Tobol and the Irtish are navigable; the Ishim is not, and in summer runs in a very small bed, about 200 ft. wide.

The bridges of small spans from 7 ft. to 140 ft. are designed to be of wood; the spans of 7 and 14 ft. will be very like the American trestle bridge; the great wooden bridges are designed to be of the Howe truss system.

The great bridges are designed to be of iron, with spans covered by semiparabolic trusses, resembling the Linville system, 350 ft. long.

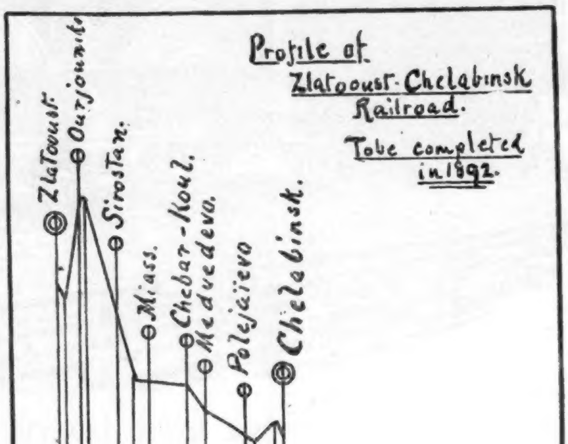
These great iron bridges are designed only over the Tobol (1,400 ft. clear length), over the Ishim (700 ft. clear length), and over the Tomi River.

Besides these on the division between Chelabinsk and the Obi River there are designed one wooden bridge of 140 ft. span over the Chik River; 335 small wooden bridges of spans from 14 to 105 ft.; three stone culverts of 7 ft. span, one culvert of 10½ ft. span, and 10 cast-iron pipe culverts of 3½ ft. diameter.

On the other or eastern side of the Obi River the spans at a number of small rivers are not yet fixed.

The Irtish and the Obi rivers, requiring bridges of 2,100 and 2,800 ft. clear length, will be provisionally crossed by steam ferries.

As noted above, the thickness of ballast is to be 12½ in., which requires about 2,850 cub. yds. per mile; the ties will be 8 ft. in length, and their number is about 2,325 per mile. The total length of sidings will be 10 per cent.

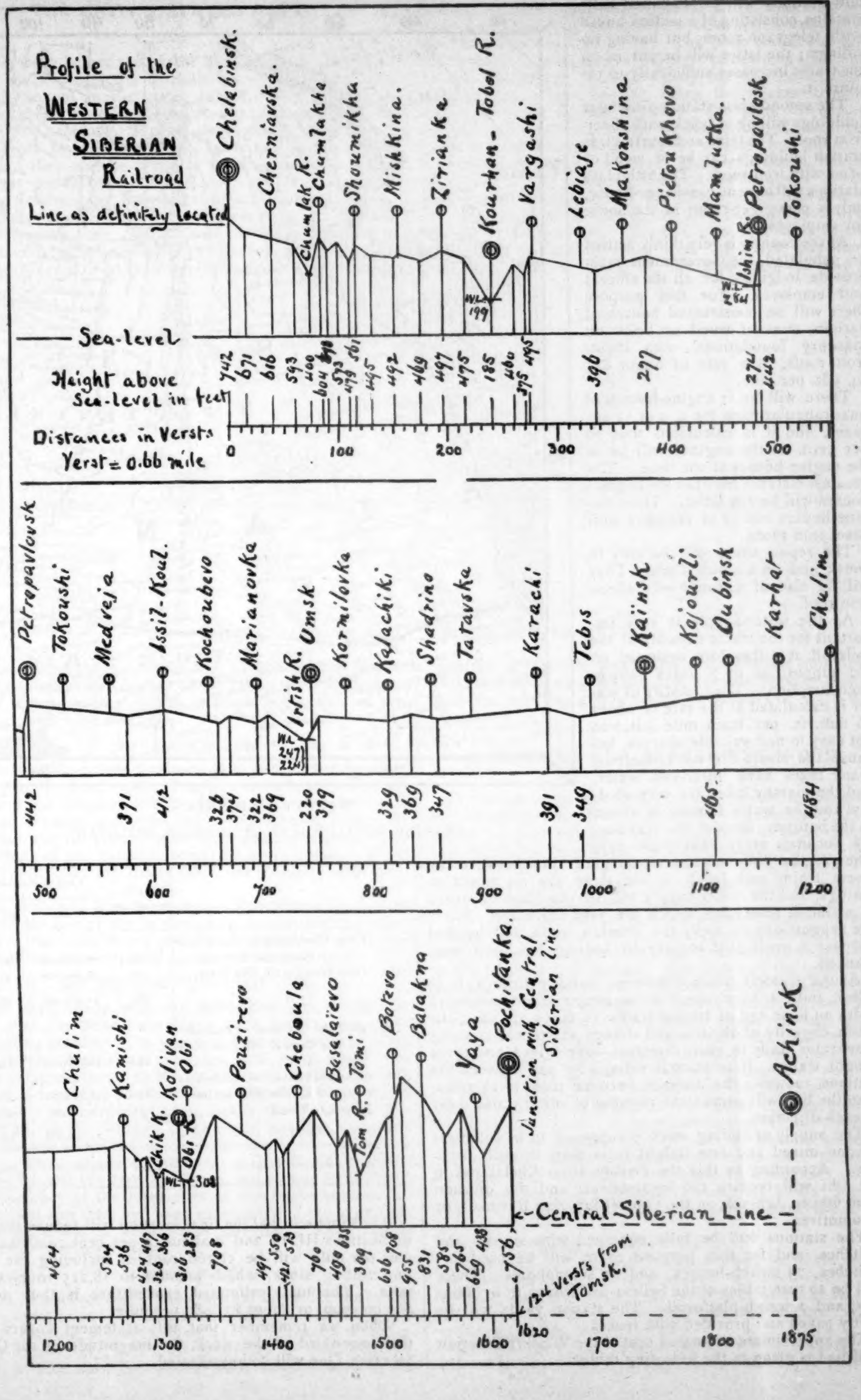


of the main track. The rails are somewhat light—54 lbs. Russian or 49 lbs. English to the yard—but this weight was fixed for the sake of economy.

For the roadmasters, road-workmen and the track watchmen there will be section-houses, great and small, and watchmen's houses. All these buildings will be constructed of brick or wood, according to the facility of getting materials. The distance between large section-houses is fixed at 12 miles; this interval is divided by small section-houses and watchmen's houses, so that the road section will be 4 miles and the watchman's beat 2 to 3 miles.

For the division between Chelabinsk and the Obi there will be required 82 large section-houses, 150 small section-houses and 184 watchmen's houses. There will be 397 road crossings.

There will be in all 33 stations built on the type generally adopted on the State railroads, two—Chelabinsk and Omsk—being rated as of the second class; four of the third class, at division points; five as of the fourth class and 21 of the fifth class. The greatest distance between stations is 33 miles. In the middle between the most dis-


Profile of the WESTERN SIBERIAN Railroad
Line as definitely located
Sea-level
Height above Sea-level in feet
Distances in Versts
Verst = 0.66 mile
Chelebinsk
Cherniavska
Chumlak R.
Chumlakha
Shoumikha
Mishkina
Ziriankе
Kourtan-Tobol R.
Vargashi
Lebiaje
Makoushina
Pietoukhovo
Mamlutka
Ishim R.
Petropavlosk
Tokoushi
Petropavlovsk
Medveja
Issil-Koul
Kochoubevo
Marianovka
Irtish R.
Omsk
Kormilovka
Kalachiki
Shadrino
Tatavska
Karachi
Tebis
Kainsk
Kojourli
Oubinsk
Karhat
Chulim
Kamishi
Chik R.
Kolivan
Obi R.
Pouzirevo
Cheboula
Baselaievo
Tom R.
Tomi
Botevo
Balakna
Yaya
Pochitanka
Junction with Central Siberian Line
Achinsk
Central Siberian Line
124 Versts from Tomsk.
W.L. 199
W.L. 284
W.L. 247
W.L. 308

tant stations will be so-called half-stations, consisting of a section-house with telegraph-room, but having no sidings; the latter will be put in as the traffic increases sufficiently to require it.

The second-class station passenger buildings will be of brick with sheet-iron roof. The third and fourth-class station buildings can be of wood or brick with iron roofs. The fifth-class stations will have no passenger-house, only a passenger-room in the house for employés.

As the country is very thinly settled or populated, the Government must provide lodgings for all the officers and employés. For this purpose there will be constructed houses of various sizes of wood or brick on masonry foundations, with sheet-iron roofs, at a rate of about 845 sq. yds. per mile.

There will be 11 engine-houses of quadrangular form for 4, 9 or 12 engines, and it is calculated that 70 per cent. of the engines will be in the engine-houses at one time. The greatest distance between the engine-houses will be 100 miles. These engine-houses will be of masonry with sheet-iron roofs.

The repair shops will be only in Omsk and on a small scale. They will be also of masonry with sheet-iron roof.

As the water-supply is very important for the traffic capacity of the railroad, it is therefore designed on the supposition of 7 trains daily in each direction. The quantity of water is calculated at the rate of about 16 cub. ft. per train mile. It was not easy to find suitable sources, because the rivers are not numerous, many lakes have bitter-salt water, and the marshy lakes are very shallow and the water freezes in winter to the bottom. Besides this the country becomes every year more dry. The greatest difficulties occur on the section between the rivers Ishim and Irtish, where there are no rivers or springs, and the water-supply will be provided by means of artificial reservoirs, which are very expensive. There are suggestions to apply the artesian wells, and for that purpose a geological inquiry by borings has been commenced.

As the greatest distance between stations (sidings) is 33 miles, and the mean speed of passenger trains will be 17 miles an hour and of freight trains 12 miles an hour, the traffic capacity of the line and sidings answers to running four trains daily in each direction—one mixed and three freight trains. If additional sidings be put between the stations, reducing the distance between them to 18 miles, then the line will permit the running of seven trains daily in each direction.

The supply of rolling stock is supposed to be sufficient for one mixed and one freight train daily in each direction. According to this the division from Chelabinsk to the Obi will require 120 locomotives, and the division from Obi to Achinsk, on the Central Siberian Railroad, 67 locomotives.

The stations will be fully equipped with signals and switches, and for this purpose there will be used 343 switches, 75 switch-houses, and 64 semaphores. There will be 10 turn-tables of the Sellers pattern, 55 ft. in diameter, and 2 weigh-platforms. The station yards will be partly paved and provided with fences.

The approximate estimated cost of the Western Siberian Railroad is given in the following table:

WESTERN SIBERIA.

SHOWING LOCATED LINE OF SIBERIAN RAILROAD.

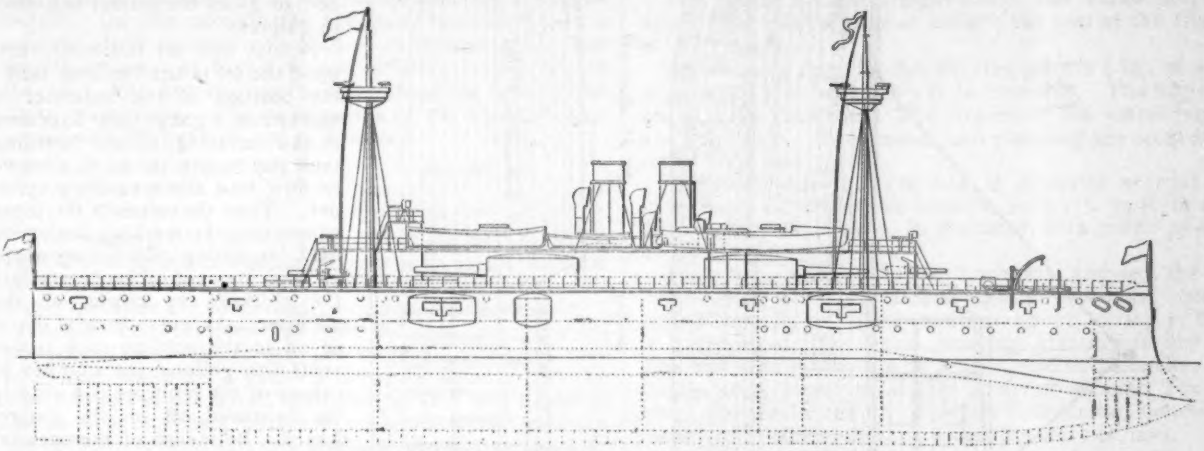
	Length in miles.	Cost in Roubles.	
		Total.	per mile.
I. From Chelabinsk to Omsk with Irtish Bridge and branch......	498	26,300,000	52,820
II. From Omsk to the Obi River...	387	16,000,000	41,340
Total	885	42,300,000	47,800
III. From the Obi River to Pochitanka on Central Siberian Railroad.	202	16,400,000	81,180
IV. From Pochitanka to Achinsk (a part of Central Siberian line)..	170	8,750,000	51,470
V. Branch to Tomsk..............	53	2,370,000	44,700
Total....	425	27,520,000	64,900
General Total...........	1,310	69,820,000	53,300

It is supposed that the final location will reduce the cost of Sections III, IV and V about 10 per cent., and that the cost per mile will be 51,760 roubles, including the rails and rolling stock, which amount to 18,215 roubles per mile. The total estimated expenditure is thus nearly $42,000,000, or about $31,980 per mile.

When we remember that this statement covers less than one-third of the work, the magnitude of the Great Siberian Line will be appreciated.

THE UNITED STATES NAVY.

As has been before stated, the next ship to be launched will be the *Texas* at the Norfolk Navy Yard, which will probably be put in the water July 1. The engines of this ship are now well advanced toward completion at the Richmond Locomotive Works, although the work on the boilers was somewhat delayed by a fire in the boiler shop, and they will be ready as soon as the ship is prepared to receive them. The launch of the *Texas* will soon be followed by that of the *Cincinnati* at the New York Navy Yard and by Cruisers 11 and 12. Of the smaller vessels, the *Detroit* will be ready for trial in August and the *Montgomery* in October, while the *Castine*, the *Machias* and the *Bancroft* will all three be ready for trial during the summer. The harbor-defense ram at the Bath Iron Works is also nearly ready for launching.



BATTLE-SHIP "TEXAS," UNITED STATES NAVY.

The accompanying sketch is from a drawing of the original design for the *Texas*.

ORDNANCE NOTES.

The Bethlehem Iron Company is to furnish the forgings for a gun of nickel steel. The gun is to be of 8-in. caliber, and the forgings will be of the same dimensions as those of the type 8-in. gun, the only difference being that the steel will be alloyed with 3 per cent. of nickel. The conditions of the contract prescribe an increase of about 15 per cent. over the limits made for ordinary steel forgings.

The Builders' Iron Foundry, of Providence, R. I., has finished the last of the 30 new 12-in. breech-loading rifled mortars, the work being completed several weeks in advance of the time required by the contract.

THE ERICSSON SUBMARINE GUN.

The trials made with the submarine gun of the *Destroyer* at the New York Navy Yard have shown some interesting results. The gun was fired a number of times at different depths under water, and while there was some disappointment as far as accuracy of direction was shown, a record of 10 shots shows that all of them would have hit a ship drawing 22 ft. below the water-line at a range of 100 ft. Nine of these would have been effective on the same vessel below the water-line at 200 ft.; four at 300 ft.; three at 400 ft., and two at 500 ft. The official report has not yet been published, but it may be said that the tendency of the projectiles to rise to the surface was somewhat less than had been expected, and the main difficulty found was in accuracy of direction. Some further trials are still in progress.

ARMOR TESTS.

The acceptance test of the diagonal armor for the battleships *Indiana* and *Massachusetts* took place at the Indian Head Proving Grounds, May 21. The results were entirely satisfactory, and most gratifying to the Naval officials, as they show that armor-plate manufactured in this country is beyond the experimental stage, and that we may now expect the construction of armored vessels to proceed without further delay. The plate tested was one of twenty 14-in. diagonal nickel steel plates manufactured by the Bethlehem Iron Company for the battle ships *Indiana* and *Massachusetts*, being the thickest armor-plates yet made in this country. The plate more than complied with contract requirements. None of the three shots fired succeeded in getting far enough into the plate to show the backing. All three shots rebounded, one of them back to the muzzle of the gun, a distance of 135 ft. The deepest penetration of any of the projectiles was 14 in. The other two showed an inch or two less. No cracks were developed. A 10-in. gun was used in the test. Two of the projectiles were the Firth, imported, and the third was made by the same process in this country. The latter was thrown out entirely uninjured. The projectiles weighed 500 lbs. and the powder charge used was 140 lbs., giving a striking velocity of 1,410 ft. a second.

A PROCESS FOR PRESERVING WOOD.

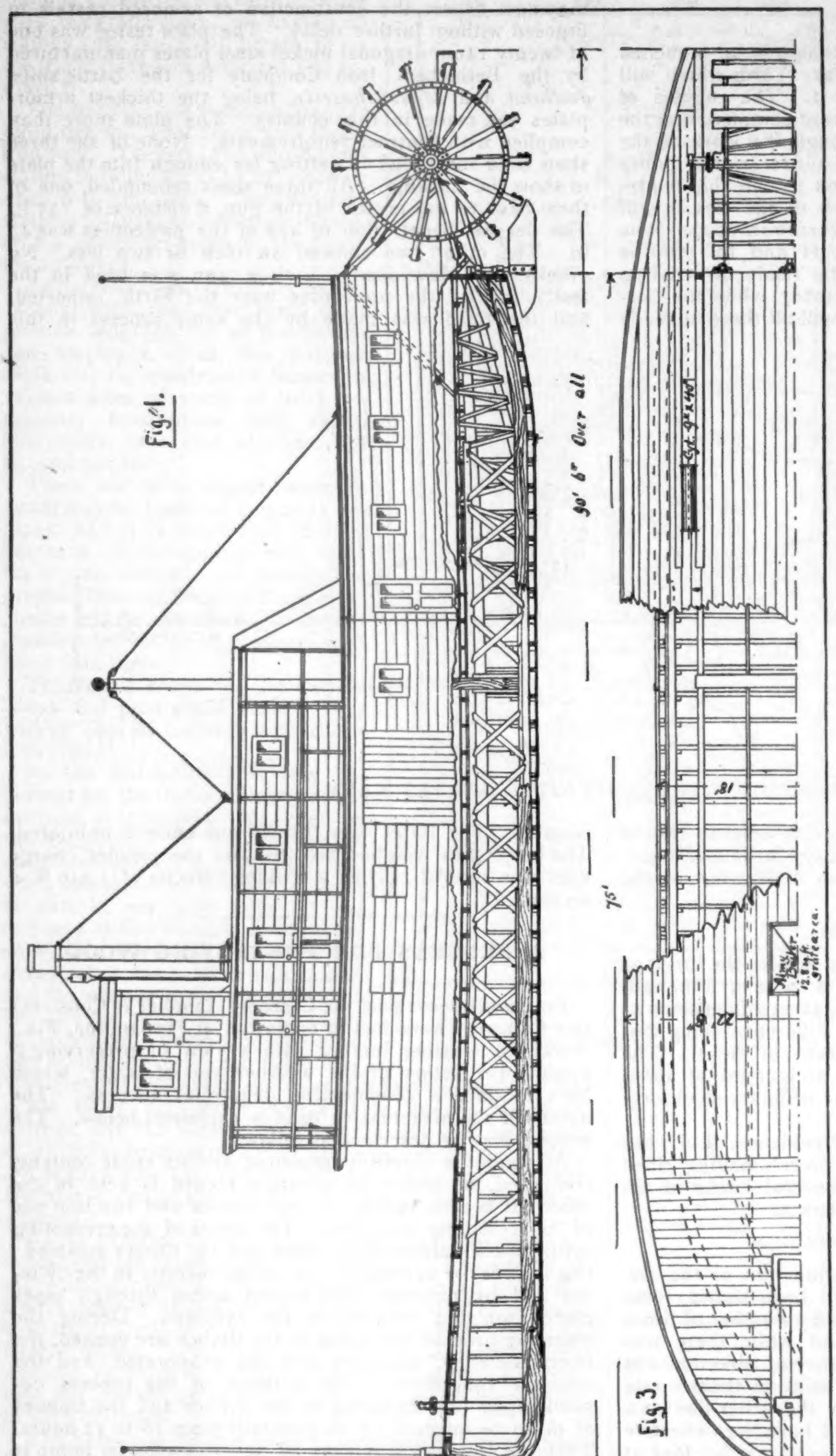
For some years past the Creosote Lumber & Construction Company have had in operation at Fernandina, Fla., works for treating lumber with a view of preserving it against the action of the weather and of water, which have attained a considerable degree of success. The nature of the preservative used is explained below. The process may be described as follows:

All timber is carefully measured and its cubic contents computed, of which an accurate record is kept in the office; it is then loaded on iron trucks and run into one of the creosoting cylinders. The doors of the creosoting cylinder are hermetically closed and the timber steamed; this is done by admitting live steam directly in the cylinder and by passing super-heated steam through pipes placed for that purpose in the cylinder. During the steaming process the pores of the timber are opened, the fibers softened, moisture and sap evaporated, and the albumen coagulated. The duration of the process depends upon the seasoning of the timber and the amount of oil to be injected; it is generally from 10 to 12 hours. Then the live steam is shut off and the vacuum pump is set to work, which withdraws the evaporated moisture and sap and discharges the same in condensed form. The duration of this process is about six hours; during this time a vacuum of from 20 to 25 in. is produced in the cylinder.

Now the charge is ready for the oil.

All the oil used for one charge is taken out of the working tank and is previously heated to about 175°. The working tank is a square iron tank 25 ft. wide, 40 ft. long and 4 ft. deep; each vertical inch or inch of depth represents 620 United States gallons.

To compute the amount of oil required for a charge the following calculation is always made; the cubic contents



of each creosoting cylinder are known, also the contents of the charge, being previously measured and computed. By subtracting the cubic contents of the charge from the cubic contents of the cylinder, the difference represents the vacant space in the cylinder—this amount can be readily expressed in gallons—the amount of oil to be injected per cubic foot of charge is known and can also be expressed in gallons, consequently the whole amount of oil to be taken from the working tank to fill the vacant space in the cylinder and to go in the timber is known in gallons.

A float with an indicator rests upon the oil in the working tank; the position of the indicator is marked on a gauge-board secured to the covering of the working tank just before the oil is allowed to flow into the creosoting cylinder. Then the valves in the pipes connecting the working tank with each creosoting cylinder are opened and the hot oil is drawn into the cylinder by means of the vacuum. As every inch of depth of oil in the working tank represents 620 gallons, the number of inches of oil required can readily be measured off on the gauge-board. By means of the vacuum a certain amount of oil is drawn into the cylinder and the balance is pumped in with the pressure pump The pressure pump is kept at work until the requisite amount of oil has been taken out of the working tank and pumped into the creosoting cylinder. As the vacant space in the cylinder is capable of holding only a certain quantity of oil, the balance of the oil must necessarily go into the timber.

The creosoting cylinders are tested to a pressure of 225 lbs. per square inch, and it generally requires from 150 to 160 lbs. of pressure to force 16 lbs. of oil per cubic foot into the timber.

When all the oil required has been taken from the working tank the charge remains standing in the creosoting cylinder until the pressure gauge shows about 40 to 50 lbs., then the oil required to fill the vacant space in the cylinder is allowed to return to the working tank and the charge is completed, the doors of the cylinder are opened and the charge is drawn out. In reviewing the main features of the process it will be seen that by this process timber will be thoroughly protected and preserved.

During the steaming process all moisture is evaporated and the albumen coagulated. During the vacuum process all vapors remaining in the timber and the cylinder are removed and the timber left in a condition best adapted to absorb the oil. The oil, being thoroughly heated before it comes

in contact with the timber, is readily absorbed by the open pores. The oil will penetrate the timber to the heart and fill all the pores vacated by the sap and moisture; the heavy and tarry part of the oil will remain near the outside of the timber and form an air-tight coat around each piece. As soon as the charge is taken out of the creosoting cylinder the fibers will somewhat contract, caused by the change of temperature, and the outer fibers on the sides of the stick will close themselves altogether and retain whatever oil has been absorbed.

For a number of years the Company has used at these works the oil obtained through the distillation of pitch pine—the so-called pine oil. While this oil, however, has done remarkably well as a preservative, its antiseptic qualities being very pronounced, it has been found within the last few years that it does not effectually protect timber against the ravages of the teredo and other marine borers. On this account the Company has lately used a mixture of the pine oil with dead oil experimentally. The results obtained at first were not satisfactory, but within the past year success has been attained in finding the right proportions. The constituents of the pine oil compared with the dead oil are as follows:

Dead Oil.	*Pine Oil.*
Naphthaline.	Paraffin.
Carbolic acid.	Creosote and Wood acids.

The missing part in the pine oil, as far as protection against the teredo is concerned, seems to be the carbolic acid, and the missing part in the dead oil, as far as antiseptic qualities are concerned, seems to be the creosote.

Paraffin is considered insoluble in acids, but from experience it would seem that too large a quantity of carbolic acid will have a decided influence upon it. In the combination given above, both the paraffin and naphthaline in these oils seem to have no other office than to retain the carbolic acid or the creosote and prevent their washing out.

The degree of success obtained with this process has been very encouraging, and wider extension of its use seems desirable The great obstacle so far to the introduction of any process of the kind has been the low price of lumber, which has made it apparently cheaper to renew wooden structures than to have the lumber of which they are composed treated. Whether this is really the case may fairly be questioned, and a careful computation might show that the treated lumber was cheaper in the long run. Whether this has been the case or not, there is no doubt that it will soon be so, as the timber supplies of the country are drawn upon and the price of lumber increases, as it is sure to do.

A LIGHT-DRAFT STERN-WHEEL STEAMBOAT.

THE accompanying drawing shows a small stern-wheel steamer, the *Florence Henry*, built near Seattle, Wash., for service on the Snohomish River in that State, and is interesting as showing very fully the construction of a boat of a class widely used, but not often built from carefully made drawings.

The boat was built by J. J. Holland, of Ballard, Wash., for the firm of Shepard, Henry & Company, who have the contract for building the Great Northern Railroad from Puget Sound to the summit of the Cascade Range. She was built under the supervision of Mr. George L. Cumine, Engineer for the contractors, to whom we are indebted for the drawings. She is employed chiefly for carrying supplies to the working camps along the Snohomish.

The *Florence Henry* has a hull 75 ft. long, 18 ft. beam and 4 ft. deep; the length over all, including the stern-wheel and frame, is 90 ft. 6 in. The main deck is 22 ft. 8 in. wide over all. She is flat-bottomed and of very light draft, even with a full load.

The drawings show the general design and the method of framing and bracing very clearly. Fig. 1 is a longitudinal section of the hull, with the deck-house shown in elevation; fig. 2 is a half cross-section, and fig. 3 is a plan, with the deck partly broken away to show the framing.

This class of boat is a very useful one, costing but little, carrying a large quantity of freight on a light draft, and capable of doing work where no other kind of craft can go.

The sizes of the timber used in building this boat are as follows: Main keelson, 4 × 10 in.; cylinder timber keelson 4 × 7 in.; trusses, chord, 3 × 5 in.; bracing, 2½ × 4 in.; bilge-strake, 2½ × 8 in.; knuckle-strake, 4 × 9 in.; deck-beams, 1¾ × 3¾ in.; plank-shear, 1½ × 8 in.; bottom planking, 1¾ × 12 in.; side planking, 1½ × 6 in.; main-deck plank, 1½ × 4 in., matched; cylinder timbers, 5 × 13 in.; wheel arms, 2 × 4 in.; buckets, 1½ × 12 in.; braces, 2 × 2 in.; rudder stalks, 2½ in. round; king-post tapered from 9 in. to 6 in.; carlins and studding for freight-house, cabin and pilot-house, ¾ × 3 in.; upper deck plank, ⅞ in., and sides, ½ in; deck stringers, 1½ × 6 in. The upper deck is covered with canvas over the planking.

The siding for the freight-house and cabin and the upper deck planking are of cedar; the rest of the timber is Washington fir.

The running rope for the steering-gear is ⅝ in., of steel wire. The pilot wheel is 5 ft. in diameter. The hog-rods are 1 in. in diameter. The braces to the wheel-frames are ⅝-in. rods. The frames and planking are secured by screw bolts and spikes.

The stern-wheel is 12 ft. 6 in. in diameter over all and 11 ft. face. There are 14 buckets, each 1 × 11 ft. in size. The wheel-shaft is 4½ in. in diameter, with crank at each end, as shown.

The wheel is driven by two horizontal engines, the cylinders being 9 in. in diameter and 40-in. stroke. Steam is furnished by an Almy tubulous boiler having 12.8 sq. ft. grate area. The usual working pressure is 200 lbs. The fuel used is wood, with a little coal occasionally, and the boiler is found to supply plenty of steam. The engines are usually run to cut off at half-stroke, sometimes increased to three-quarters, when the work is hard.

THE FOLSOM DAM.

FROM a long and interesting article in the Sacramento *Union* the following description of the great dam and water-power on the American River at Folsom, Cal., is condensed:

As long ago as 1866 the foundation was laid for this dam across the American River, at a point about two miles above Folsom and one-third of a mile above the locality where was subsequently located the Folsom State Prison. The work has been continuously in progress, either on the dam or the canal leading from it. In 1868 the State of California became interested in the work, receiving a conveyance of the site for a prison, and a grant of water-power privileges on the canal, at the said prison, in consideration of giving the aid of convict labor in the construction of the dam and canal.

In 1874 additional concessions of lands were received by the State, enlarging the site for its proposed State Prison, in consideration of additional grants of convict labor to construct the work. Owing, however, to unforeseen delays in the completion of the prison, it was not until 1881–82 that the State commenced to discharge its contract to furnish convict labor.

The Folsom Water Power Company had, in the mean time, acquired the property from the original owners, with all its franchises and contract rights. Differences of interpretation as to the contract of the State to furnish convict labor led to litigation, wherein the decision was against the State, and a temporary suspension of work by the State convicts followed.

The late Governor Waterman, advised thereto by the energetic and clear-sighted Warden of the Folsom Prison, Charles Aull, recognized that most valuable interests of the State were being allowed to lie dormant, perhaps ultimately to be entirely sacrificed, and on the Governor's initiative, backed by the active co-operation of the then Board of State Prison Directors, a new contract was entered into on May 5, 1888, between the State and the Folsom Water Power Company, providing for a large increase in the magnitude of the dam and canal, for a proportion-

ally more ample water-power privilege to the State at the prison, and for a necessarily increased contribution of convict labor by the State.

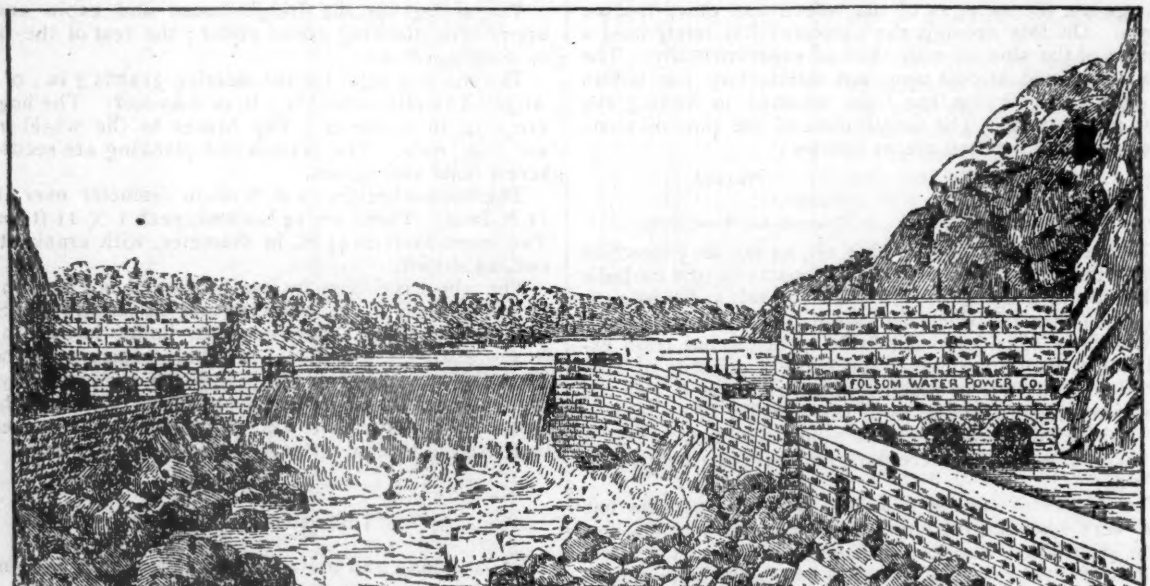
Under this modified contract, work was at once actively commenced, and has been since vigorously prosecuted with all the force of the labor available at Folsom Prison, and of an immense outfit of steam machinery furnished and operated by the Folsom Water Power Company.

Additions to the dam, head-gates and retaining wall of Section 1 of the Eastside Canal have made the work one of far greater magnitude than was at first contemplated, entailing a proportionate increase of time in construction.

The dam, head-gates and Section 1 retaining walls, down to the location of the State Power House, were, however, finally finished some months since, and are of an

The work remaining now to be done, for the completion of Section 1 of the canal, is the construction of the walls, gates, etc., connecting the State Power House, both at the inlet and outlet, with the canal; also of a railroad bridge across the canal to give the State access to the prison yard and quarries. This work, it is expected, can be completed in three or four months.

When so completed the entire force will be transferred to Section 2 of the canal, and as this portion of the work is entirely excavation and dry retaining wall of rubble, it has none of the difficult features which have made Section 1 so long in construction. It is therefore considered reasonable to calculate that the balance of the canal may be completed, to the Folsom terminus of the canal, in about one year from the time work is commenced on Section 2.



THE FOLSOM DAM, AMERICAN RIVER, CALIFORNIA.

extent and stability scarcely equaled by any similar work in the world. For a more full understanding of these works the following details are instructive:

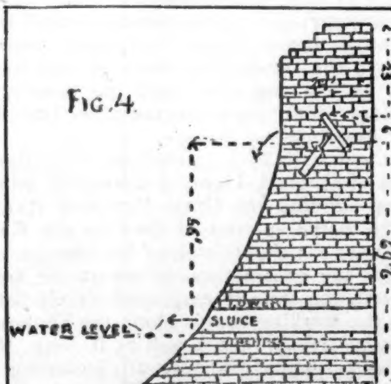
The height of the dam is 89 ft.; width on top, 24 ft.; width on bottom, 87 ft.; length, 650 ft.; masonry contents, 48,590 cubic yards. The material is granite blocks of the most solid character and of the largest dimensions, laid in the best of English Portland cement, of which over 20,000 barrels were consumed in the dam and head-works.

The head-gates to the Eastside Canal are three in number, each being 16 ft. wide. The head-gates to the Westside Canal are also three in number, each 15 ft. wide. The Eastside Canal is 50 ft. wide on top, 35 ft. wide on the bottom and 8 ft. deep. The Westside Canal is 40 ft. wide on top, 30 ft. wide on the bottom, and 6 ft. deep.

The work on the State Power House, situated on the State Prison grounds, at the end of Section 1 of the Eastside Canal, designed for the utilizing of the power at the State Fall, has occupied the entire attention of the working force for the past year, and has, like the dam and head-gates, proved a much larger undertaking than was calculated upon. Not until its completion can the dam and head-gates be utilized for the diversion of the waters of the river, since all the water taken into the canal at the dam must pass through the wheels of the State Power House, where there is a fall of 7.33 ft., yielding to the State upward of 800 H.P.

The State Power House proper is now practically finished, and its machinery nearly all placed therein, forming one of the most unique examples of mechanical achievement to be seen anywhere in the United States.

The fall of the American River, from the dam to the Folsom terminus of the canal, is 82 ft., and there will be upward of 70 ft. of fall available at the Folsom terminus for power purposes. This will afford 7,707 H.P., which,



on the basis of 75 per cent. actual efficiency of the waterwheels, will yield 5,770 H.P. effective.

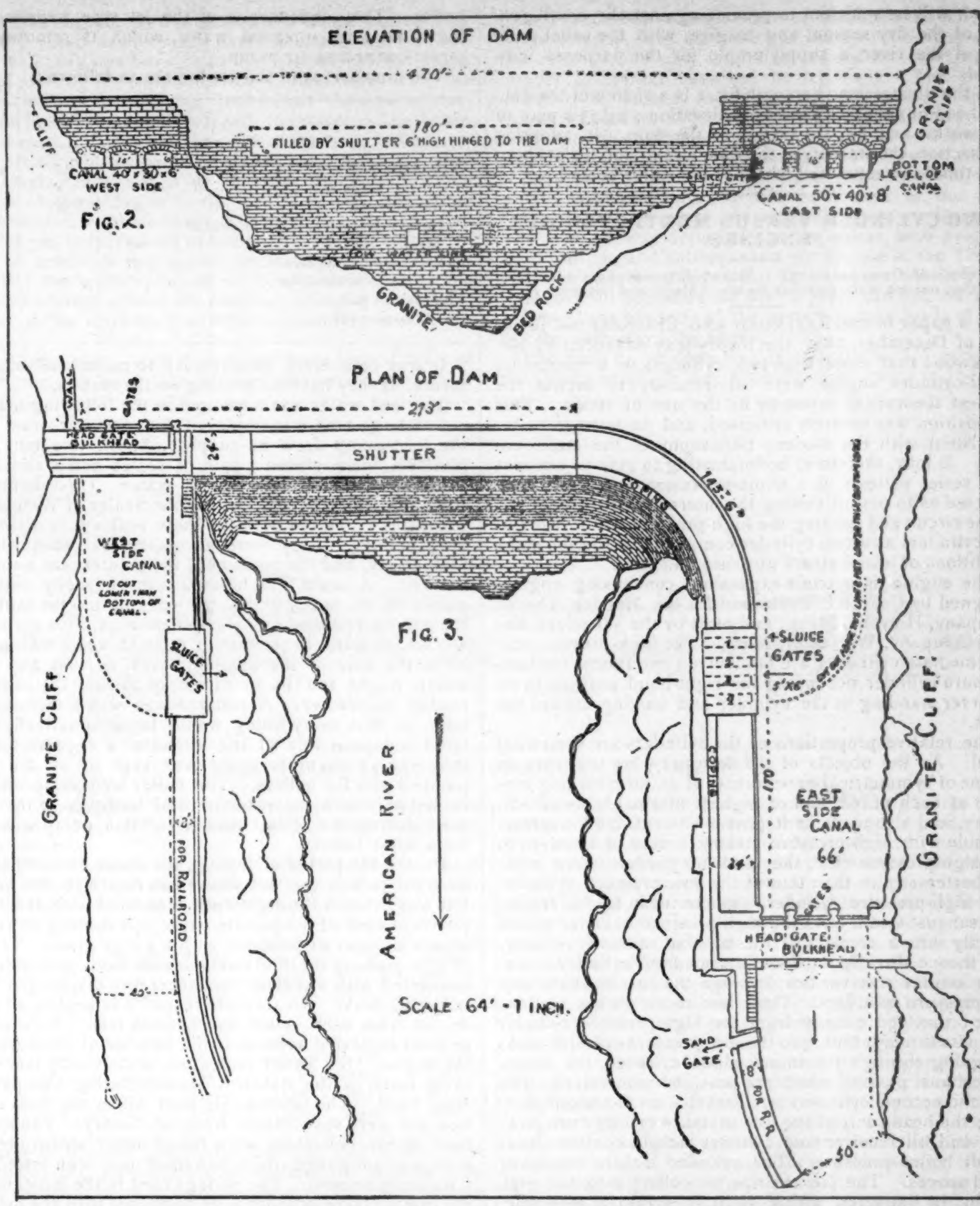


FIG. 2.

FIG. 3.

Should it, for any reason, be deemed desirable, power may be developed at the end of Section 1 immediately upon its completion. At this point the canal must be discharged back into the river during the construction of Section 2. There is here a fall of 35 ft. and upward, which would develop upward of 2,000 effective H.P. were it decided to develop the power here, temporarily, without waiting for the completion of the canal to the Folsom terminus.

It is probable that this course will be adopted, in order to furnish power to the mills and factories of the American River Land & Lumber Company, with whom the Folsom Water Power Company has made a contract to furnish mill sites, power, etc., on its canal near the Folsom terminus.

It is contemplated, however, that most of the power will find its market in Sacramento City, transmitted there by electricity, the distance being about 20 miles in an air-line.

Arrangements to this end have already been perfected whereby the Sacramento Electric Power & Light Company will, by contract with the Folsom Water Power Company, receive a large portion of the power of the latter company, and, converting it into electricity, will transmit it to Sacramento City, there to be used for the lighting of the city and furnishing motive power for street cars, and for manufactures of all kinds.

Still more extensive plans, however, are entertained by the Company. It is proposed to use the water-supply not only for power, but also to supply the city of Sacramento and to furnish water for irrigating lands throughout the valley. The dam is situated 210 ft. above the level of the sea, and is therefore about 175 ft. above the level of Sacramento City. The basin, or reservoir, above the dam is upward of three miles long, and has an area of 5,850,000 surface feet. The dam is fitted with a timber shutter, operated by hydraulic cylinders, and which, when closed, will raise the water 6 ft. over the entire area, giving an additional storage of 35,100,000 cub. ft. This, it is be-

lieved, will be sufficient to provide against the contingencies of the dry season, and to give, with the usual daily flow of the river, a supply ample for the purposes indicated.

In the illustrations herewith fig. 1 is a sketch of the dam and head of canal; fig. 2 is an elevation; fig. 3 a plan of the works, and fig. 4 a section of the dam. In adopting this section, the stability of the dam was calculated at about four times the estimated thrust of the water behind it.

TWO-CYLINDER VERSUS MULTI-CYLINDER ENGINES.

(Paper by S. M. Green and George I. Rockwood, presented at the San Francisco meeting of the American Society of Mechanical Engineers.)

In a paper in the Railroad and Engineering Journal of December, 1891, the theory was advanced by Mr. Rockwood that more than two cylinders in a compound multi-cylinder engine were unnecessary to secure the highest theoretical economy in the use of steam. This proposition was severely criticised, and declared to be inconsistent with the modern philosophy of the steam engine. It may, therefore, be interesting to give an account of a series of tests of a triple-expansion engine so constructed as to permit cutting the intermediate cylinder out of the circuit and running the high-pressure and low-pressure cylinders as a two-cylinder compound, using the same conditions of initial steam pressure and load.

The engine is a triple-expansion, condensing engine, designed by George I. Rockwood for the Merrick Thread Company, Holyoke, Mass., and built by the Wheelock Engine Company, Worcester, Mass. The high-pressure and intermediate cylinders are tandem on one frame, the low-pressure cylinder occupying the right-hand position to an observer standing at the cylinder and looking toward the shaft.

The relative proportions of the cylinders are somewhat novel. As the objects of the designer were to secure an engine of symmetrical appearance, of uniform turning moment at each crank, and of highest attainable steam efficiency, and also to make it possible to run the low-pressure side with high-pressure steam, in case of accident to the high-pressure side, the tandem cylinders were made of shorter stroke than that of the low-pressure cylinder. The high-pressure cylinder was put next to the frame. The exhaust steam from the high-pressure cylinder passes directly into a receiver of the tubular re-heater variety, and thence directly into the intermediate cylinder. Another similar receiver lies between the intermediate and low-pressure cylinders. These two receivers are so connected that the exhaust from the high-pressure cylinder may pass through both into the low-pressure cylinder without going through the intermediate cylinder, the steam and exhaust pipes of which are provided with valves. The first and second cylinders are jacketed on heads and barrels; the heads only of the low-pressure cylinder are jacketed, and all receiver and cylinder jackets contain steam at full boiler pressure. The cylinder jackets consist of cored spaces. The jacket-drips all collect into one pipe 1½ in. in diameter, which discharges into a reservoir, whence it is returned through a steam loop to the boiler, and in no instance are the jackets connected with the cylinder steam-chests.

The valve-gear of the high-pressure cylinder is of a new type, designed to operate gridiron valves under heavy pressures. The valve gears of the intermediate and low-pressure cylinders are, in all respects, such as have been used heretofore on engines built by the Wheelock Engine Company. The governor operates only upon the cut-off mechanism of the high-pressure cylinder, the releasing gears of the other two cylinders having independent hand adjustments. In case of accident to the high-pressure side of the engine, however, means are provided for connecting the governor with the cut-off mechanism on the low-pressure cylinder.

The engine is located at some distance from the boiler (a Manning upright of 175 rated H.P.), the supply pipe being 325 ft. in length. A separator, placed about 10 ft. from the engine, collects the entrained and condensed water, which is also returned through a steam loop to the boiler. The condenser is of the jet type, supplied from the canal with injection water, which is removed by a direct-connected air pump.

The dimensions of the engine are as follows:

	H.P.	I.	L.P.
Diameter of cylinder	12″	16″	$24\frac{13}{32}$″
" " piston rod	2 and 2¾″	2″	3¼″
Stroke of piston	36″	36″	48″
Clearance in percentage of piston displacement	2%	4%	3%
Inside diameter steam pipe	5″	6″	9″
" " exhaust pipe	6″	7″	10″
Area of steam port	13″	21″	38″
" " exhaust port	16.5″	25″	60″

It was considered unnecessary to make coal measurements, as they have no bearing on the results.

The feed-water was measured in the following manner: One large tank was employed as a reservoir, from which the feed-pump drew its supply. Above this tank, on a platform, were placed a pair of scales and a small tank which held about 400 lbs. of water. (Just before the trials the scales were sealed by the Sealer of Weights and Measures.) To the beam of these scales was attached a long pointer. They were accurately balanced with the tank empty, and the position of the pointer was noted and marked. A scale weight of 400 lbs. capacity was then placed on the beam, and water was run into the tank until the pointer resumed its balanced position, thus giving just 400 lbs. of water in the tank. A small valve was provided in the side of the weighing tank, so that any water which might run in, in excess of the 400 lbs., could be readily withdrawn. A counter was also attached to the tank, so that every filling would be automatically registered independently of the attendant's registration. In this way an accurate count was kept of all the water pumped into the boilers. The boiler feed-pump was connected only with the reservoir and feed-pipe to the boiler used during the tests. Steam for this pump was taken from other boilers.

During the period of testing, the water of condensation from the jackets was not allowed to return to the boilers, but was drained through pipes connected with the lowest points in each of the jackets, each pipe leading down to a separate reservoir provided with a gauge glass. The discharge pipe, ½ in. in diameter, from each reservoir, was connected with a surface condenser and discharged into a weighing tank. An accurate record was kept of all water drawn from each jacket during each test. A revolution counter indicated accurately the number of revolutions of the engine. Six Tabor indicators were kindly loaned for these tests by the Ashcroft Manufacturing Company, of New York. The instruments were all in the best condition and were sent directly from the factory. The springs used in the indicators were tested under steam pressure with a steam-gauge which had itself just been tested with a mercury column. The springs used in the indicators on the low-pressure cylinder were compared with the mercury column employed instead of a vacuum-gauge. The steam-gauges were also tested with a test-gauge.

For determining the quality of the steam after passing through the separator a Peabody throttling calorimeter was connected with a perforated ½-in. pipe, screwed several inches into the elbow of the steam supply pipe at its point of juncture with the high-pressure cylinder, the connections and calorimeter being thoroughly covered with hair felt.

The following description of the tests will illustrate the manner in which each trial was conducted.

At 1 P.M., the engine having been running for 15 minutes, electric bells were sounded in the engine and boiler rooms, the heights of the water in the boiler and in the lower tank were measured, the reading of the scale counter was noted, the heights of water in the various jacket reservoirs were taken, and the test began.

During the trials, simultaneous indicator diagrams lasting ½ minute were taken every half hour, which was considered often enough in view of the exceedingly steady

load on the engine; and pressures and temperatures were carefully noted each time. Every hour the water in the boiler and tank was brought to the heights observed at the time of starting the test, and observations were made for a check on the final result. Just before the time of closing, the boiler pump was stopped, the water in the boiler was allowed to fall below the point of starting, and at precisely six o'clock the bells were sounded, the engine shut down, and steam was shut off from the jackets. The heights of the water in boiler and tank were brought to the same level as at starting.

Three preliminary tests of the engine were thus run, in order to accustom the attendants to their duties. In all the tests made, the reading of the thermometer in the calorimeter was practically constant, showing a uniform degree of moisture in the steam amounting to 2.64 per cent.

On Wednesday, April 6, two five-hour formal trials of the engine, run as a two-cylinder compound, were held. During Thursday, a holiday, the change was made to a triple-compound, and on Friday two five-hour trials were again made.

The general results are given in the table below—tests A and B being those made with the engine running compound, and C and D with the three cylinders:

Test.	R. P. M.	Average Steam-Pipe Pressure.	Average Indicated Horse-Power.	Water per I. H. P. per Hour	Dry Steam per I. H. P. per Hour.	Weight of Water used in Jackets, per Hour.
				Lbs.	Lbs.	Lbs.
A....	79.2	142.	187.11	13.41	13.06	330.3
B....	79.3	142.	180.71	13.11	12.76	330.3
C....	79.0	142.	199.08	13.01	12.67	416.0
D...	79.0	143.	178.16	13.25	12.90	388.8

These results are practically identical, and would seem to support Mr. Rockwood's theory that the receiver may be so constructed as to take the place of the intermediate cylinder or cylinders of the multi-cylinder engine. As these tests were held so shortly before the spring meeting of the Society, the time allowed in which to prepare this paper was much too limited to admit of the exhaustive treatment which the importance of the subject demands. It is hoped that at the next meeting the results of further trials, together with their proper analyses, may be presented for further consideration. But the results of these tests, it is believed, show an economical performance surpassing the best records hitherto published in this country, and clearly indicate that more than two cylinders are unnecessary to secure the highest attainable economy in the use of steam.

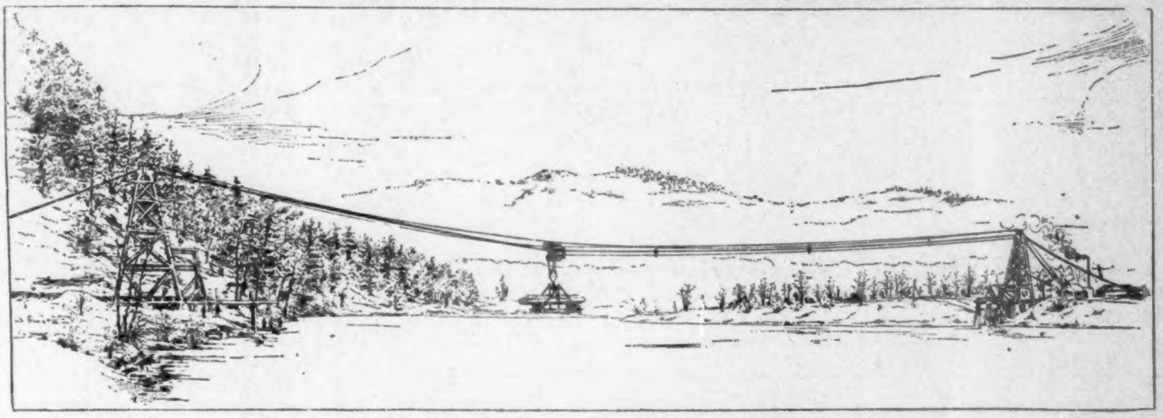
A NOVEL CABLE TRANSFER.

(Condensed from paper read by E. G. Spilsbury before the American Institute of Mining Engineers.)

A FEW miles above Williamsport, Pa., on the Susquehanna River, the Glen Union Lumber Company, of Pottsville, Pa., owned a large tract of valuable timber land. Unfortunately, it is on the right bank of the river, while the railroad, the only available means for carrying the lumber to market, runs on the left bank. The river is about 750 ft. wide at this place, and the cost of a bridge to carry the cars over was practically prohibitory, as it threatened to consume the profits of the business for many years. Several plans for obviating the difficulty, such as a ferry or a floating bridge, were proposed; but these were considered impracticable by reason of the rapid floods and ice gorges to which the Susquehanna is subject. The problem was submitted to the writer, who proposed as a solution, and subsequently put up, one of the Trenton Iron Company's cable hoists. This transfer has now been in successful operation for over a year, and has thoroughly proved the capacity of the system to take loads of 20 or 30 tons over very long spans.

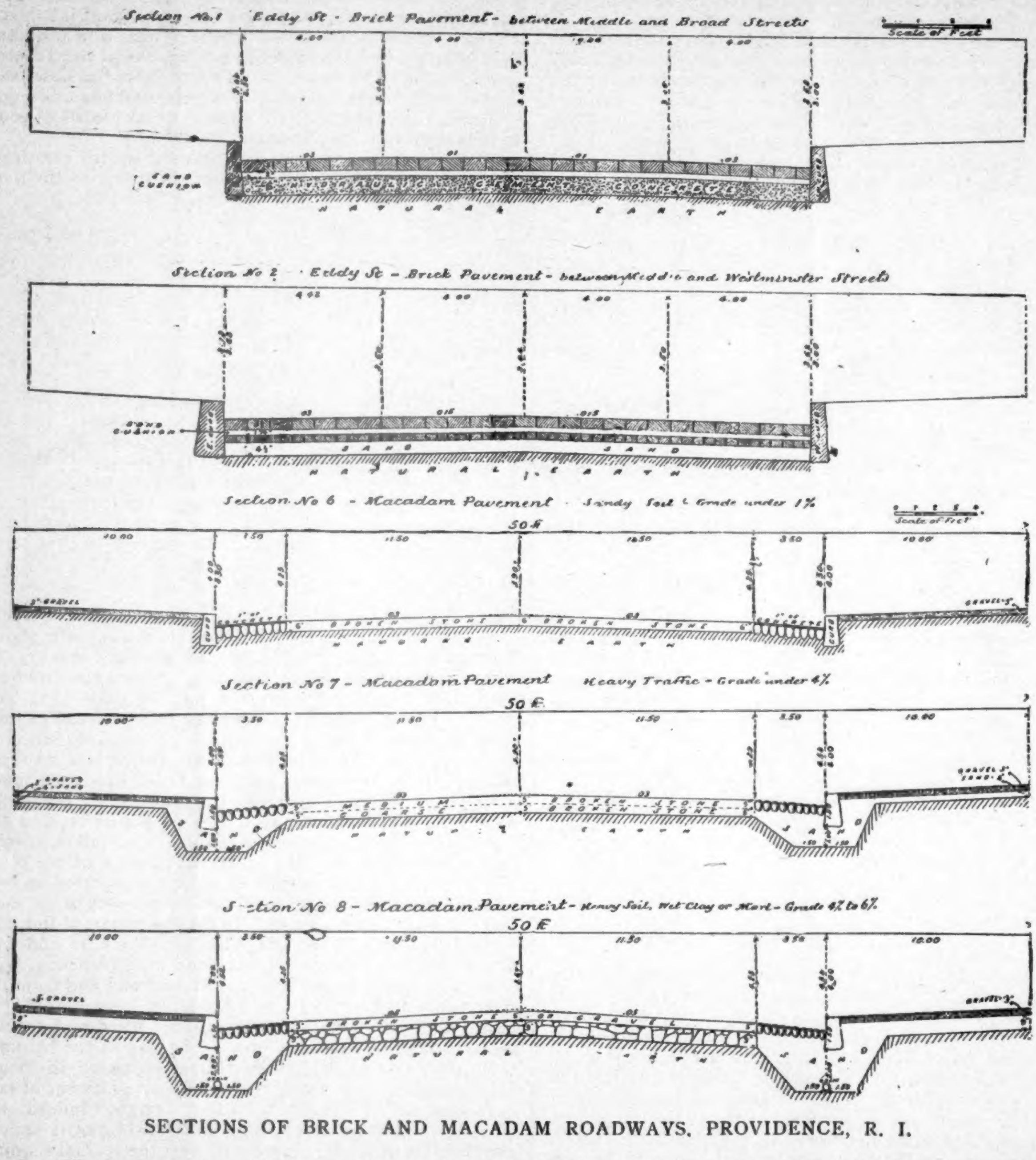
The work to be done was to take the loaded cars from the tracks on which they were brought down to the river bank, and to deliver them without unloading on the tracks of the Philadelphia & Erie Railroad on the opposite shore. The shortest span which could be obtained was 733 ft. The accompanying sketch shows the general construction. Two 70-ft. towers were erected, one on each bank, and over the tops of these were stretched two steel cables each 2 in. in diameter, each cable having a breaking strain of about 125 tons. In order to equalize the strains on these cables, and so keep them always parallel, they were made in one continuous length, the two loose ends being anchored rigidly on the railroad side of the river, and the bight at the other end passing round a 6-ft. sheave, revolving in a shackle attached to the anchorage on the other bank. On these cables runs a carriage supported on four wheels, and moved back and forth by means of an endless cable 1 in. in diameter. In the lower part of this carriage are placed the hoisting-sheaves, which, in conjunction with a large fall-block, hoist the load vertically, high enough to free it from the tracks at each end and from the river at its highest stage in the middle. A wrought-iron lattice-work cage, 36 ft. in length and fitted with tracks, receives the car at each end. The sag of the hauling-ropes and also of the hoisting-rope, which on so long a span would be very great, is taken up by a number of fall-rope carriers of the Locke patent design. Indeed, the whole arrangement of carriage and fall-blocks is only a modification of Locke's system to meet the special requirements of the case. The power required to operate the system is furnished by a 50-H.P., specially designed engine, built by the Lidgerwood Manufacturing Company. The total load carried is about 26 tons, including the cage and car; the estimated load of lumber being 12 tons. The trip across the river is made in about three minutes. The total cost of the whole structure completed was less than one-fifth the cost of a bridge, even of the lightest design.

During its operation last winter and spring, no delays occurred from ice-gorges or freshets. After it had been running for some months, however, it was found that the wear on the tread of the carriage-wheels was very great. This was obviously due to the uneven surface of the ropes, which tended to cut a spiral thread on the grooves corresponding



CABLE TRAMWAY ACROSS THE SUSQUEHANNA RIVER.

to the lay of the strands in the rope. Of course, it would not do to make these wheels of harder material than the rope, since it is cheaper to replace them than it would be to wear out the rope; but, at the same time, the cost of replacing the wheels threatened to lessen greatly the economy of the whole system. Hence, it has now been determined to replace the two main cables of the ordinary make by two of the smooth-coil Elliot locked-rope cables, the use of which entirely obviates all this wear on the wheels. These ropes are now being manufactured, and I hope to present, at some future meeting, figures thoroughly demonstrating the great advantages of these ropes over all others for just such purposes.



SECTIONS OF BRICK AND MACADAM ROADWAYS, PROVIDENCE, R. I.

SOME GOOD ROAD SECTIONS.

FOR the accompanying diagrams, showing cross-sections of streets laid with brick pavement, and cross-sections of macadamized roads, we are indebted to the annual report of Mr. J. Herbert Shedd, City Engineer of Providence, R. I. They are good specimens of careful work.

Sections No. 1 and 2 represent brick pavement laid in Eddy Street. This pavement was laid as an experiment, being the first brick pavement laid in a roadway in the city. It was laid in four different ways; one-half of the pavement (see Section No. 1) having a hydraulic cement concrete foundation, the other half (see Section No. 2) having brick laid flat and lengthwise of the street. The bricks forming the wearing surface were laid edgewise and across the street on a cushion of sand about 2 in. in depth. A portion of the joints was filled with sand and another portion was filled with a paving cement, composed of coal-tar pitch and ordinary paving cement in the following proportions: One barrel of coal-tar pitch and one-half barrel of cement.

Sections No. 6, 7 and 8 represent macadamized streets. The cross-section or crown in each case is made to conform to the longitudinal grade, so as to carry the surface water coming to the street to the gutters as quickly as possible; the transverse rate varying from .03 to .08 per foot.

Section No. 6 represents a cross-section of a street having light traffic. The natural material found at sub-grade is sand. The cobblestone used for gutters is covered with

concrete top-dressing where the grade is less than 1 per cent.

Section No. 7 represents a cross-section of a street having heavy traffic, and where the material found at sub-grade is clay, marl, or of such a nature as is liable to be affected by the frost. The broken stone in this street is laid in two layers, the lower layer being composed of the coarsest stone taken from the crusher, and is rolled thoroughly into place by the heavy steam roller.

Section No. 8 represents a cross-section of a street where the material found at sub-grade is heavy soil or wet clay, the lower layer being composed of refuse stone, placed loosely, so as to underdrain the roadway. The upper layer of broken stone is then applied and thoroughly rolled.

ALUMINUM AND ITS USES.

(Condensed from lecture by Alfred E. Hunt, C.E., in the *Journal* of the Franklin Institute.)

ALUMINUM is now being made throughout the world upon a commercial scale only by processes of electro-deposition from fused electrolytes. In this country, the Pittsburgh Reduction Company and the Cowles Electric Smelting & Aluminum Company are the only concerns manufacturing commercially and furnishing the American market with aluminum. In Great Britain, the Metal Reduction Syndicate, Limited, a branch of the Pittsburgh Reduction Company; and in Switzerland, the Aluminium Industrie Actien Gesellschaft, manufacturing at Neuhausen, using the water-power of the falls of the Rhine; and in France, the firm of Bernard Brothers, now building works at St. Michaels, and operating the Minet process, are, so far as the writer's knowledge goes, the only manufacturers now whose metal is met in the competition of the world's rapidly growing market for aluminum. These statements need to be made preliminary to any considerations of the purity or other qualities of the commercial aluminum of the markets of the present day, for the reason that manifestly it will not be fair to take into consideration, in treating of the commercial aluminum of to-day, the impure products made only on a small scale by the great number of processes being experimented upon.

Both the Neuhausen concern and the Cowles, as well as the Metal Reduction Syndicate, Limited, of Patricroft, Lancashire, England, and the Pittsburgh Reduction Company, find no trouble by the electrolytic process in producing regularly metal with less than 1 per cent. of impurity. Indeed, the best results in quantity of output and regularity of working, and therefore in economy of manufacture, are when producing the purest aluminum, and it only requires further development of the manufacture of the aluminum oxide used as the ore and of the carbon anodes—matters which are perfectly practicable and possible—to obtain almost absolutely chemically pure aluminum by the electrolytic methods now in use.

I have already, in a previous lecture, in February, 1891, before the Boston Society of Arts, stated that the cost of manufacture, under the most favorable conditions with water-power and large output, would be approximately 20 cents per pound. Nearly one year's experience and careful study of the matter leads me to reiterate the statement then made, and to prophesy that the ingot metal will be made by the Hall process within the next few years at *a cost* of between 18 and 20 cents per pound; the items of cost being about one-third for the ore, one-sixth for the expenditure of other materials than ore, one-third for the electrical current expended, one-twelfth for labor and superintendence, and one-twelfth for general expenses, interest and repairs.

Aluminum will not be manufactured by any process at much less than at present, nor will it be sold at much lower rates, until the output be measured in tons, and not pounds, per day. The lowering of the market price of aluminum in the future will be gradual, and will be directly proportionate to the decrease in cost of manufacture, due to increased capacity of the manufactories.

The properties of aluminum which will probably give it the greatest availability in the arts are:

1. Its relative lightness.
2. Its non-tarnishing quality as compared with many other metals; aluminum not being acted upon by sulphur fumes at all, and being very much more slowly oxidized by moist atmospheres than most of the metals.
3. Its extreme malleability.
4. Its easy casting qualities.
5. The influence of the metal in various alloys will give it advantages, some of which I will try to enumerate and call to your attention.
6. Its high tensile strength and elasticity when weight for weight of the metal is compared with other metals, and especially when alloyed with a small percentage of titanium, silver or copper and properly worked by being rolled or hammered or otherwise drawn down.
7. Its high specific heat and electrical and heat conductivity.

Unfortunately, aluminum is not, section for section, as has been widely claimed, comparatively a very strong metal. It is only about as strong under tensile strain, section for section, as cast iron, and has less than one-half the strength of wrought iron under ordinary conditions. Under compression, the metal, unfortunately, has a very low elastic limit, although its extreme ductility allows the metal to flow on itself so freely as to make it for special purposes a very safe metal to use in compression.

The same remark applies to transverse tests of aluminum. It is not a rigid metal at all, and bends under transverse strains very readily.

Under torsional stress, the metal has much lower modulus of rigidity than iron or steel; its maximum shearing stress in castings is about 12,000, and in forgings about 16,000, being about that of pure copper. The angle of torsion is about equal to that of the softest steel.

The tensile strength of aluminum wire runs up very considerably over that of the rolled metal. This is due to the peculiar property of aluminum to harden under work. The metal requires frequent annealing in rolling; and if it is to be drawn into wire with as little annealing as possible, the tensile strength is increased very considerably. This property of the metal is increased, especially if the aluminum is alloyed with a small percentage of copper, titanium or silver.

Two things, however, should always be borne in mind in considering the applicability of aluminum for given purposes in the arts. The first is that the properties of the metal are very considerably changed as regards strength, tenacity, hardness, rigidity and color, by alloying it with small percentages of other metals, conditions that do not materially change the specific gravity of the metal. The second is the relative weight of aluminum; taking the tensile strength of aluminum in relation to its weight, it is in plates as strong as steel at 80,000 lbs. per square inch ultimate strength, and in cold-drawn wire as strong as steel at 180,000 lbs.

The specific gravity of aluminum is one of its most striking properties; it varies from 2.56 in ingots to 2.70 in forged bars. The weight of a given bulk of this metal compares with others as follows:

Aluminum	1.00	Nickel	3.50
Wrought iron	2.90	Silver	4.00
Structural steel	2.95	Lead	4.80
Copper	3.60	Gold	7.70
Ordinary high brass	3.45	Platinum	8.60

A cubic inch of cast aluminum weighs 0.092 lb.; of rolled sheet metal, 0.098 lb.

Wherever momentum is to be overcome, as in the reciprocating parts of many forms of machinery, aluminum can be advantageously used.

Aluminum does not oxidize so as to interfere at all with the strength of thin sections of the metal as do iron and steel; the thin film of oxide which covers surfaces of the metal which have been long exposed to moist atmosphere seems to prevent its being further acted upon. But it does give a surface tarnish to the metal which cannot be rubbed off with the usual metal polishing compounds without interfering with the surface of the soft metal. This, however, can be removed by rubbing with a flannel rag which has been immersed in a 2 per cent. solution of hydrofluoric acid and then again rubbing up the polish

with a rag saturated with carbon oil. Special aluminum polishes have been devised which work very efficiently. When properly cared for, polished surfaces can thus be kept bright for a remarkably long time.

As compared with most metals, pure aluminum, under ordinary circumstances, withstands the action of wind and weather exceedingly well; and many uses to which the metal is now being successfully applied are based upon this fact. The presence of silicon in aluminum materially detracts from its power to withstand corrosion due to atmospheric influences. Metal with 4 per cent. or 5 per cent. of silicon very soon collects a thick coating of oxide upon it, if severely exposed. The fact that pure aluminum is not severely acted upon by boiling water or by steam has led to its successful use as a packing or gasket in steam connections, where lead and similar metals have been rapidly cut out, as in parts of steam and water pumps and difficult steam joints.

For structural purposes under water, where metals are required, aluminum seems to be especially adapted to replace the more easily corroded cast and wrought iron and steel now in general use for such purposes. For liners and shims upon masonry foundations, aluminum is well adapted, as it flows sufficiently to allow equal bearings on all parts; it is less easily cut out than lead, and much more durable than tinned iron sheets which are now in general use under heavy structures of metal resting on metal shims on masonry.

Aluminum sheets will make a much more durable and satisfactory roofing than sheet copper now generally used in valuable buildings.

Pure aluminum is very sonorous, and its tone seems to be improved by alloying with a small percentage of silver or titanium. For the sounding-boards of musical instruments, aluminum has been proven to be well adapted.

Pure aluminum, when properly treated, is a very malleable and ductile metal. It can readily be rolled into sheets 0.0005 in. thick, or be beaten into leaf nearly as thin as gold leaf, or be drawn into the finest wire. Pure aluminum stands third in the order of malleability, being exceeded only by gold and silver; and in the order of ductility, seventh, being exceeded by gold, silver, platinum, iron, soft steel and copper. Both malleability and ductility are greatly impaired by the presence of the two common impurities, silicon and iron.

Aluminum can be rolled or hammered cold, but the metal is most malleable at and should be heated to between 350° and 400° F., for rolling or breaking down from the ingot to the best advantage. Like silver and gold, aluminum has to be frequently annealed, as it hardens up remarkably upon working. Due to this phenomenon of hardening during rolling, forging, stamping, or drawing, the metal may be turned out very rigid in finished shape, so that it will answer excellently well for purposes where the annealed metal would be entirely too soft, or too weak, or lacking in rigidity to answer. Especially is this true with aluminum alloyed with a small percentage of titanium, copper or silicon. It can be safely stated, as a general rule, that under similar conditions the purer the aluminum, the softer and less rigid it is.

Aluminum can be annealed by heating and allowing to cool gradually; the best temperature is just below the red heat. Thin sections can be annealed by heating in boiling water.

Aluminum can be easily and readily welded by electrical apparatus, and a cheap and satisfactory solder has been discovered.

Sound castings of this metal can be made in dry sand moulds or metal chills. It requires, however, some experience to master its peculiarities before sound castings can be uniformly made. The aluminum should not be heated very much beyond the melting point; if too hot it seems to absorb gases which remain in the metal, preventing sound castings. In small quantities the metal can be best melted in plumbago crucibles; but in large quantities it can be more economically melted in a reverberatory furnace with alumina or magnesia brick sides and alumina bottom. The furnace should have a tap-hole for drawing off the liquid metal into carbon-lined ladles. In no case need the metal be covered with a flux to assist in the fusion or to form a covering of slag. In fact, owing to the metal's lightness, the presence of any flux will tend to unsoundness, due to particles of it becoming entangled in the castings, while impurities may perhaps be added to the metal by the action of the flux on the lining of the melting vessel. The shrinkage of $\frac{17}{64}$ in. per foot, which aluminum has, is considerably more than that of brass, which is about $\frac{3}{16}$ in. per foot.

Undoubtedly, one of the greatest uses for aluminum in the arts will be in the form of alloys with other metals. Aluminum in proportions of a small percentage added to very many different metals gives valuable properties. Among these alloys is, of course, aluminum bronze. The alloys of from 2½ per cent. to 12 per cent. aluminum with copper have so far achieved the greatest reputation. With the use of 8 per cent. to 12 per cent. aluminum in copper, we obtain one of the most dense, finest-grained and strongest metals known, having remarkable ductility as compared with its tensile strength. A 10 per cent. aluminum bronze can be made in forged bars with 100,000 lbs. tensile strength, 60,000 lbs. elastic limit, and with at least 10 per cent. elongation in 8 in. An aluminum bronze can be made to fill a specification of even 130,000 lbs. tensile strength and 5 per cent. elongation in 8 in. Such bronzes have a specific gravity of about 7.50, and are of a light yellow color. For cylinders to withstand high pressures, such bronze is probably the best metal yet known.

A small percentage of aluminum added to Babbitt metal gives very superior results, increasing the durability and wearing properties of the alloy. It is a little softer than the ordinary Babbitt, but in comparative tests has given very satisfactory results. One advantage of this alloy is its extreme malleability. It can be hammered out to a thin edge without cracking. An advantage of this is that for bearings the aluminum Babbitt can be rolled into shape for inserting in the dove-tailed recesses, which can be cut and drifted out at a very small expense, and the amount of Babbitt required is reduced to a minimum.

Aluminum is also being used very successfully in steel castings, and has added very considerably to the progress which has been made within the last two years in obtaining sound steel castings. A large number of steel casting companies are regularly using the metal aluminum in quantities of from one-half pound to several pounds of aluminum to the ton of steel In the manufacture of ordinary steel ingots by the open-hearth and Bessemer processes, it has lately been shown in the article on "Aluminum in Steel Ingots," by Professor J. W. Langley, at the January, 1891, meeting of the American Institute of Mining Engineers, that the use of aluminum in small proportions (from one-third to three fourths of a pound of aluminum to the ton of steel) has proved to be an economical success, preventing blow-holes and unsound tops of ingots.

Alloys of aluminum with copper in proportion of from 2 per cent. to 15 per cent. have been advantageously used to harden aluminum in cases where a more rigid metal is required than pure aluminum. Copper is one of the most common metals used at present to harden aluminum. A small percentage of copper decreases the shrinkage of the metal and gives alloys that are especially adapted for art castings. The remainder of the range, from 15 per cent. copper up to over 85 per cent., give crystalline and brittle alloys of no use in the arts; which are of a grayish-white color, up to 80 per cent. copper, where the distinctly yellow color of the copper begins to show itself.

With the exception of lead, antimony and mercury, aluminum unites readily with all metals; and many useful alloys of aluminum with other metals have been discovered within the last few years, and I prophesy that many more will be found within the next few years. I consider this field as one of the most promising for investigation of any of the "aluminum problems." The useful alloys of aluminum so far discovered are all in two groups, the one of aluminum with not over 15 per cent. of other metals, the other of metals containing not over 15 per cent. of aluminum; in the one case, the other metals imparting hardness and other useful qualities to the aluminum, and in the other, the aluminum giving useful qualities to the other metals.

Titanium and chromium can be readily alloyed with

aluminum according to methods devised and patented by Professor John W. Langley. This will probably prove to be the most valuable means of hardening aluminum ; a small percentage of titanium rendering the metal, under work, very rigid and yet elastic at the same time. Chromium is the best metal for hardening aluminum castings ; the triple alloy being best adapted where a very hard and yet elastic material is required.

More or less useful alloys have been made of aluminum with bismuth, nickel, cadmium, magnesium, manganese and tin, these alloys all being harder than pure aluminum ; but it is by combinations of these metals, with additions, perhaps, of copper, lead and antimony, that alloys of most value have so far been discovered. Some are additions of only 1 per cent. to 2 per cent. of aluminum.

The modifications of pewter, britannia, white metal, delta metal, and the like, with additions of aluminum, have shown very useful qualities, and will add very considerably to the demand for aluminum in the near future.

The following alloys have recently been found useful : Nickel-aluminum, composed of 20 parts nickel and 8 parts aluminum, used for decorative purposes ; rosine, composed of 40 parts nickel, 10 parts silver, 30 parts aluminum, and 20 parts tin, for jewellers' work ; sun-bronze, composed of 60 parts cobalt, 10 parts aluminum, 40 parts copper ; metalline, 35 parts cobalt, 25 parts aluminum, 10 parts iron and 30 parts copper.

Professor Emmens has great hopes for an alloy of aluminum-bronze and nickel for a gun metal.

The addition of from 5 to 15 per cent. of aluminum to type-metal composed of 25 per cent. antimony and 75 per cent. lead makes sharper castings and more durable type.

To ordinary brass the addition of aluminum gives superior strength and better anti-corrosive qualities.

Aluminum has been successfully used to replace lithographic stone.

Powdered aluminum mixed with chlorate of potash is used to give a photographic flash-light, which gives much less smoke than the magnesium compounds used.

The Tacony Iron Metal Company, a well-known Philadelphia concern, has successfully produced an aluminum coating for iron, which undoubtedly will have considerable use in the future.

To the inventors who shall produce good methods of nickel, silver and gold-plating aluminum, so that it can take the place of German and nickel-silver, a rich reward is in waiting.

THREE-RAIL TURNOUTS FOR DOUBLE-GAUGE TRACKS.

By James K. Geddes, C.E.

(Concluded from page 277.)

We will not discuss the other cases that may occur, where the switches are trailing switches, as distinguished from the facing switches discussed, or turnouts from the outside of a curve, where the main track is to the left and the turnout to the right, with facing and trailing switches.

From what has been previously said, it will be readily seen that the frog angles remain the same, the only difference being in the way in which the frogs are curved.

It may readily be seen that the turnout does not necessarily curve in a different direction from that of the main track.

The length of the radius of the turnout may continue to increase till it reaches infinity, where the turnout curve becomes a tangent.

In this case the problems arising may be solved from the formulæ given for turnouts from tangents, by regarding the turnout as the main track, and the main track as the turnout.

Likewise the turnout may be from the outside of the curve, and the curve be in the same direction as that of the main track. Here it is evident that the radius of the turnout must be greater than that of the main track. If the two radii are equal, the curves must coincide, and there will be no turnout. If the radius of the turnout be less than that of the main track, the turnout must necessarily be from the inside of the curve. Where the turnout is from the outside of the curve and the turnout curve is in the same direction as the main track curve, we may, for the purpose of solving the problems that may arise, regard the main track as the turnout curve and the turnout as the main track, when the problems will be identical with those for the solution of turnouts from the inside of the curve.

From what has gone before, the Engineer will note that where the turnout is from a tangent, the frog angle is equal to the central angle. Thus, in fig. 4, the frog angle $D\,B\,E = B\,A\,C$.

Where the turnout is from the inside of a curve, the frog angle is equal to the difference between the two central angles. Thus, in fig. 11, the frog angle $B\,A\,C = K\,B\,A - B\,C\,A$.

Where the turnout is from the outside of a curve, the frog angle is equal to the sum of the two central angles. Thus, in fig. 19, the frog angle $D\,A\,E = A\,B\,G + A\,C\,F$.

To find the radius of the turnout curve R' from the outside of the curve, given the radius of the main track $= R$, the gauge $= g$, and the frog angle $D\,A\,E = B\,A\,N = K\,B\,A + H\,C\,A$, fig. 22.

In the triangle $A\,C\,B$, fig. 22,

$$AC+HC : AC-HC :: \text{tang.}\ \tfrac{1}{2}(AHC+HAC) : \text{tang.}\ \tfrac{1}{2}(AHC-HAC)$$

now	$A\,C = R + \frac{1}{2}\,g$
	$H\,C = R - \frac{1}{2}\,g.$
Hence	$A\,C + H\,C = 2\,R$
and	$A\,C - H\,C = g.$
Also	$A\,H\,C + H\,A\,C = 180° - H\,C\,A.$
The frog angle	$D\,A\,E = B\,A\,N,$
and	$A\,H\,C = 180° - A\,H\,B = 180° - H\,A\,B.$

The angle

$$HAC = 180° - HAN = 180° - (HAB + BAN) = 180° - (HAB + DAE)$$

As above, the angle

	$A\,H\,C = 180° - H\,A\,B$
and	$H\,A\,C = 180° - (H\,A\,B + D\,A\,E)$
hence	$A\,H\,C - H\,A\,C = D\,A\,E.$

Substituting in above proportion,

$$2\,R : g :: \text{tang.}\ \tfrac{1}{2}\,(180° - H\,C\,A) : \text{tang.}\ \tfrac{1}{2}\,D\,A\,E.$$

Since the tang. $\frac{1}{2}\,(180° - H\,C\,A) =$ tang. $90° - \frac{1}{2}\,H\,C\,A$, substituting, we form the equation,

$$\textit{tang.}\ 90° - \tfrac{1}{2}\,H\,C\,A = \frac{2\,R \times \textit{tang.}\ \frac{1}{2}\,D\,A\,E}{g};$$

but, as before remarked, since the tangent of 90° minus a given angle is equal to the cotangent of the given angle, we have the equation,

$$\textit{cot.}\ \tfrac{1}{2}\,H\,C\,A = \frac{2\,R \times \textit{tang.}\ \frac{1}{2}\,D\,A\,E}{g}. \qquad (27)$$

Since $D\,A\,E = H\,C\,A + H\,B\,A$, to find $H\,B\,A = K\,B\,A$, we have $H\,B\,A = D\,A\,E - H\,C\,A$.

Example : Given the radius of the main track, $R = 2864.93$, the frog angle $D\,A\,E = 7°\ 09'\ 10''$, the gauge $g = 4$ ft. $8\frac{1}{2}$ in. $= 4.708$, to find the central angle $H\,C\,A$, fig. 22 :

$2\,R = 5729.86.$	……………………	3.7581441
$\frac{1}{2}\,D\,A\,E = 3°\ 34'\ 35''$	……….*tang.*	8.7958867
$g = 4.708$ ar. comp.	………………	9.3271635
$\frac{1}{2}\,H\,C\,A = 0°\ 45'\ 11\frac{1}{2}''$	……….*cot.*	1.8811943

whence $H\,C\,A = 1°\ 30'\ 23''$,
and $K\,B\,A = (7°\ 09'\ 10'') - (1°\ 30'\ 23'') = 5°\ 38'\ 47''$.

In the triangle $A\,C\,B$, fig. 22, we now have the angles and the side $A\,C = R + \frac{1}{2}\,g$, given to find the side $B\,A = R' + \frac{1}{2}\,g$.

From trigonometry,

$$R' + \tfrac{1}{2}\,g = \frac{R + \frac{1}{2}\,g \times \textit{sin.}\ H\,C\,A}{\textit{sin.}\ K\,B\,A}. \qquad (28)$$

Example : Given the radius of the main track, $R =$

2864.93, the frog angle $D\ A\ E = 7°\ 09'\ 10''$, the gauge $g = 4'\ .\ 8\frac{1}{2}'' = 4.708$, to find the radius R' of the turnout curve, fig. 22.

Having found from equation 27 the angle $H\ C\ A = 1°\ 30'\ 23''$, and deduced the angle $K\ B\ A = 5°\ 38'\ 47''$, we use equation 28 as follows:

$R + \frac{1}{2}\ g = 2867.284$	3.4574708
$H\ C\ A = 1°\ 30'\ 23''$ ....*sin.*	8.4197644
$K\ B\ A = 5°\ 38'\ 47''$ ar. comp..... *sin.*	1.0070550
$R' + \frac{1}{2}g = 766.11$	2.8842902

whence by subtracting the $\frac{1}{2}$ gauge $= 2.354$, the radius of the turnout R' is found to be 763.756.

THE CHORD DISTANCE.

Having as above found the radius of the turnout curve, the chord distance $H\ A$, fig. 22, may be readily found in a manner like that employed for turnouts from the inside of curves.

Thus in the right-angled triangle $M\ B\ A$, fig. 22, we have the three angles and the side $B\ A = R' + \frac{1}{2}\ g$ given to find the side $A\ M = M\ H = \frac{1}{2}\ A\ H$.

From trigonometry,

$$A\ M = (R' + \tfrac{1}{2}g) \times sin.\ M\ B\ A,$$

which equation is identical with equation 20 for the case there discussed.

To find the length of the arc $H\ A$ from the heel of the switch to point of frog, fig. 22. It is evident that this problem may be solved by an equation of the form of equation 8, substituting arc $A\ H$ for arc $B\ H$, the same equation answering whether the turnout is from a tangent or from the inside or the outside of a curve.

In conclusion, it may be well to say that practice does not require any iron-clad adherence to nice mathematical calculations. In some cases considerable labor may be saved by the use of the "rule of thumb" or "short-cut" rules in common vogue, especially in the case of turnouts from a tangent. Creditable work here, as in much other work of its class, requires common-sense judgment as to what is necessary and what is not.

Thus in putting in three-rail turnouts from a tangent, with the first frog No. 8 (gauge 4 ft. 8½ in.) requiring a lead from head-block to frog-point of 52.9, I have found that this distance may be lengthened or shortened at least 2 ft., without in any visible manner affecting the appearance or usefulness of the turnout.

A bright foreman with a good eye for line will (with a little practice) readily put in these switches in a creditable manner, without any stakes being given by the engineer, provided only that he be furnished with frogs of the required angles properly curved.

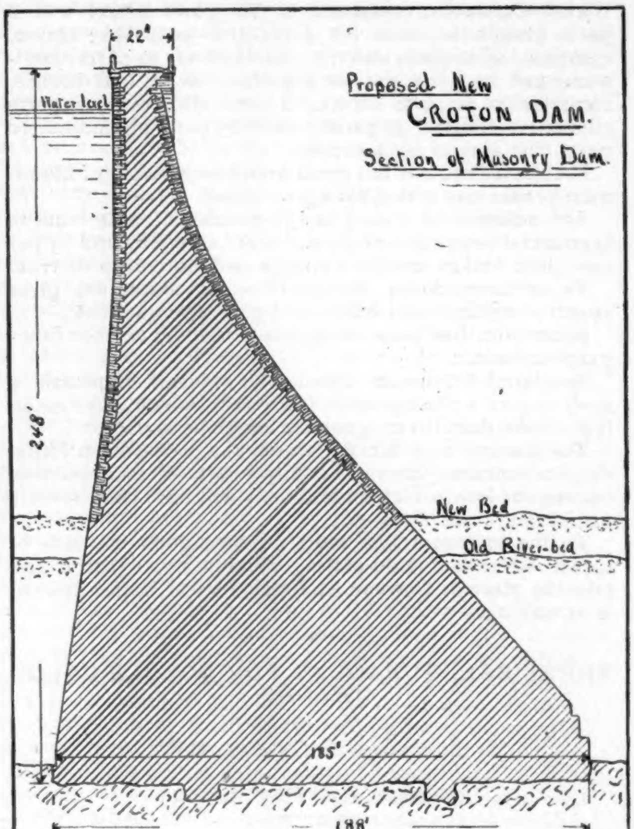
THE NEW CROTON DAM.

THE New York Aqueduct Commission has passed by the plans for the erection of the Quaker Bridge Dam, about which so much was said and written some time ago, and has decided upon the construction of a new dam on what is known as the Cornell site, which is one of those recommended by Chief Engineer Fteley. The grounds of this decision are that a dam at this place will cost much less than at Quaker Bridge, and can be built in a shorter time, while the storage capacity of the basin behind the dam will be nearly as great. It is estimated that the structure on the Cornell site can be completed, with all the auxiliary works, within seven years, and that the storage capacity of the basin will be about 30,000,000,000 gallons, which, with the storage reservoirs already constructed and to be constructed on the upper waters of the Croton and its branches, will give a secure supply sufficient for the needs of the city for several years to come. In other words, it is believed that with this dam and the storage provided, the full capacity of the Croton water-shed can be utilized, and that any further demand for water will have to be made by drawing from the water-shed of the Housatonic Valley. The latter, however, is so far in the future as not to require present consideration.

Acting upon this decision the Aqueduct Commissioners called for bids for the work on the new dam on May 17, the time set for receiving the bids being June 15.

The new dam will cross the Croton Valley some distance below the present or old Croton Dam, and will consist of three parts. The first part, beginning on the southern side of the valley, will consist of an earth dam with a masonry core. The core will be of rubble masonry in cement, with a foundation in the rock well below the river-bed, and will taper from 18 ft. at the foundation to 6 ft. at the top. The earth dam will be 30 ft. in width at the top, with slopes of 2 to 1, and will be faced on the up-stream side with 18 in. of broken stone and 2 ft. of stone pavement. It will extend for a little less than one-half the distance across the valley.

The second portion will be a masonry dam about 700 ft. in length extending across the deepest part of the valley. The height of this structure at the central part will be 248 ft. from the foundation to the coping, the founda-



tion being in the bedrock some 80 ft. below the present bed of the river. It will vary in thickness from 185 ft. at the foundation to 22 ft. at the top, and will be of the section shown in the accompanying sketch. The main body of this dam will be composed of rubble stone masonry set in cement, the facing being of cut stone in Portland cement mortar. A roadway will be carried across the top and continued over the overflow by a bridge.

Near the northern bank of the stream this masonry dam will turn almost at right angles, and will be carried along parallel to the side of the valley, forming an overflow nearly 1,000 ft. long, making the total length of the masonry about 1,650 ft. The top of the overflow, by which the water level is determined, will be 14 ft. below the coping of the main dam.

Some idea of the extent of this work will be had from the statement that the estimated quantities include nearly 600,000 cub. yds. of earth excavation; 300,000 cub. yds. of rock excavation; 900,000 cub. yds. of earth embankment, and nearly 600,000 cub. yds. of masonry. A new channel is to be provided for the Croton River during the construction of the Dam.

THE ALMY TUBULOUS BOILER.

THE illustration herewith shows a compact form of water-tube boiler, which may be added to those tubulous boilers which have been described and illustrated in previous numbers of the JOURNAL. In those articles the peculiar advantages of this class of steam producers have been referred to, and it is only necessary here to describe the present one as a very good example of its class. The boiler shown was built for the torpedo-boat *Stiletto;* it has, with forced draft, furnished steam for a triple-expansion engine indicating from 550 to 600 H.P. It was built for the *Stiletto* by the Almy Water Tube Boiler Company, of Providence. In the engraving the casing is shown with a portion broken away so that the construction can be seen. The boiler has the following dimensions: Grate area, 29¼ sq. ft.; heating surface, 1,090 sq. ft.; weight complete, with casing, 14,700 lbs.

The heating surface of this boiler is composed of 1-in. steel pipes which are disposed as shown, making their turns with bends and elbows connecting to four-way branch fittings, and these are connected by a union to flange nipple at top and bottom manifolds. There is a manifold in the form of a rectangle below the grates with a mud drum in center at the back cross-section which forms the base of each furnace. The top manifolds are four sections running parallel, connecting with an enlarged heater across the front. The elements which rise from back of boiler extend across at right angles to heating surface, forming the crown of fire-box. Between the vertical pipes which form middle wall of furnace is placed a wall of fire-brick, which completely

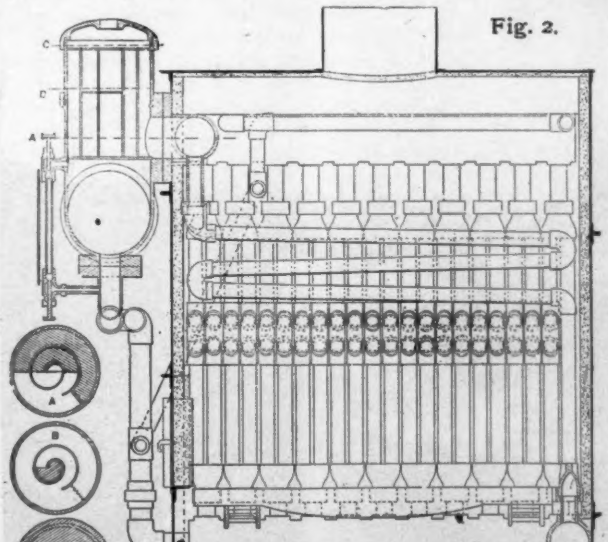
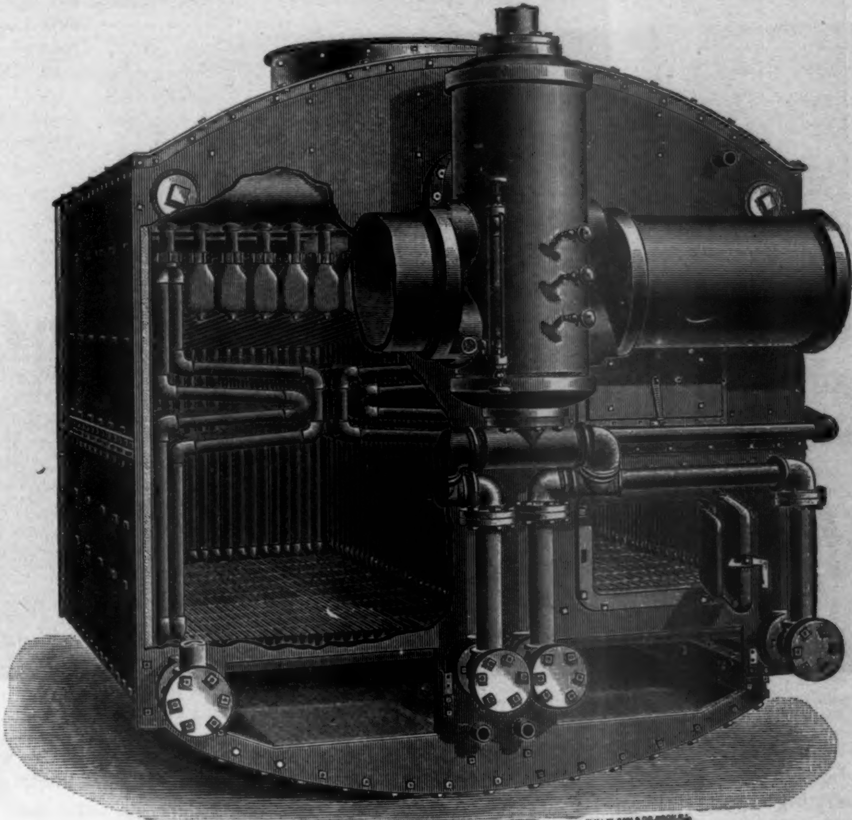


Fig. 2.

divides the two furnaces. Each of the elements which form the side and crown of the fire-box can be removed from the furnace without disturbing the casing, by simply removing the grates and unscrewing unions at top and bottom; the fore-and-aft section can be removed from the back.

There is ample room to get to the top end of all the elements from the back of the boiler by removing a small section of casing arranged for that purpose. The whole internal heating surface of the boiler may be removed and



replaced from the front, without taking down separator or disturbing the top manifold or casing, except the front sheet. The arrangement of heating surface is such that the gases, after leaving the furnace, have to pass at right angles to heating surface and through very narrow channels, which bring them in contact with the metal. Another point in this arrangement of heating surface is, that it is all water surface from the grate-line to the vertical nipples which connect to top of manifold. Each element is independent of the other, and can be stopped off or removed very easily, and the boiler can go on with its work with but a short interruption. It will be noticed that the fire-box walls are composed of double rows of tubes, which increases the heating surface relative to the weight and grate surface, besides making the circuit short and the pipes of smaller diameter, thus permitting the boiler to be driven very hard when occasion demands it.

The system of pipes when completed is cased in either sheet steel or iron, lined with asbestos, the fire-box being in addition lined in front with fire-brick. This casing is made in sections and bolted to angle-iron in such a way that any section may be readily removed, enabling repairs to be made without trouble.

The water is fed to the boiler in such a manner that it is subjected to the heat of the escaping gases just before they reach the flue, which, of course, conduces to economy and efficiency. Steam is taken through a separator which is placed in front, and which operates on the centrifugal principle for the separation of water from the steam, if there be any present. A jet of steam or hot water introduced through openings in the casing is used to clean soot or ashes from the pipes. Fig. 2 shows a longitudinal section of a marine boiler, showing more clearly the arrangement of the tubes.

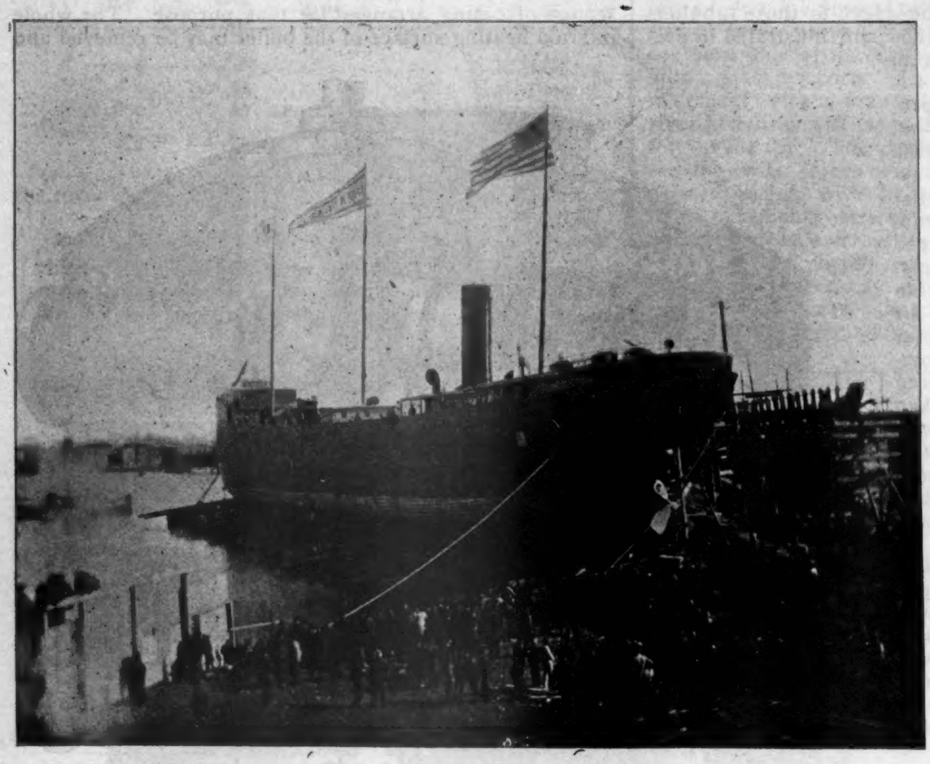
This boiler is of the non-explosive class—that is, any failure is confined to a single element, and there can be

no general destruction of the boiler. Repairs can be made easily by taking out a weak or injured section and inserting a new one.

This boiler has in a high degree the advantages of its class, the capacity to raise steam quickly and to stand very high pressures and the economy in space and weight. There can be no question that for many kinds of service these will much more than counterbalance the disadvantages charged to the type in the small volume of water carried, and the necessity for care in feeding and firing to obtain good results, especially in continuous work. In the boiler under consideration much of this objection is met by the arrangement of the steam-drum and the method of feeding, which makes the circulation complete and continuous. It has done excellent service, both in marine and stationary work.

A LAKE SHIP-YARD.

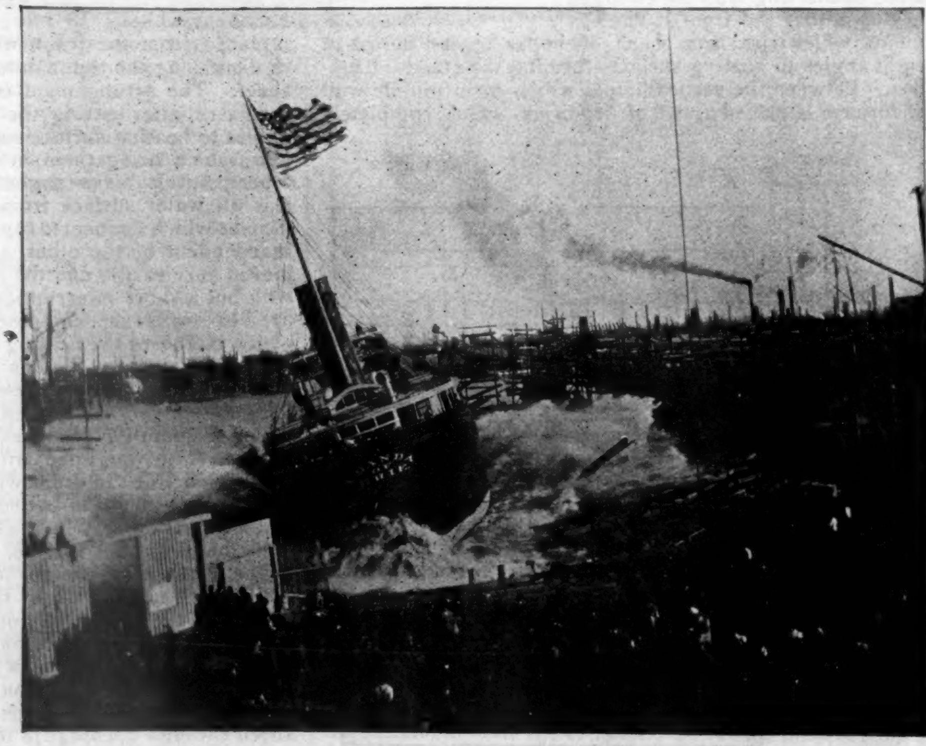
ONE of the largest shipyards on the great lakes, which may be considered a typical lake yard, is the establishment of F. W. Wheeler & Company, at Bay City, Mich. Here both wooden and steel vessels are built, and a great variety of work is done. A view recently taken of the steel plant shows four large vessels on the stocks, although several have lately been launched, and a short account of the work done there will be interesting.



ON THE WAYS AT THE WHEELER YARD.

Among the vessels lately completed are Lightships Nos. 51, 52, 53 and 54 for the Lighthouse Department, No. 51 having been launched April 23 and Nos. 52 and 53 together on May 7. These ships were described and illustrated in the JOURNAL for August, 1891, and the plans and specifications there given have been completely carried out with but one change —a compound engine, with cylinders 14 and 24 × 16 in., having been substituted for the single cylinder engine originally proposed. The fourth boat, No. 54, is nearly ready.

Another vessel nearly completed is the *W. H. Gilbert*, a freight boat for the Hollister line, which will be the largest carrier on the lakes. The dimensions are: Length on keel, 328 ft.; length over all, 345 ft.; breadth, molded, 42 ft.; extreme breadth, 42 ft. 6 in.; depth, molded, 24 ft.; depth of hold, 12 ft. 3½ in.; between decks, 8 ft.; displacement on 16 ft. draft, 5,380 tons; co-efficient of fineness, 79 per cent. The four-bladed sectional propeller is 14 ft. diameter and 16 ft. 6 in. pitch; it is driven by a triple-expansion engine with 23-in., 37-in. and 62-in. cylinders with 44 in. stroke. There are three cylindrical boilers 12 ft. diameter and 12 ft. 6 in. long, built to work at 160 lbs. pressure. As with many other boats of the same class, the boilers are on the main deck, and the machinery is very far aft, the center of the high-pressure cylinder being only 14



A LAUNCH AT THE WHEELER YARD.

ft. from the after side of the stern-post. She has water ballast.

The yards and machine shops are now very busy, employing 600 men; among the work lately completed are the engines for the lightships; compound engines for a twin-screw tug; compound engines for the new steamer *Lora*, and triple-expansion engines for the steamer *Ossifrage*, which was recently cut in two and lengthened out 31 ft. 6 in. Two other steamers are being made ready, besides a steam yacht 96 ft. long, of steel.

Some large wooden vessels are also built here. The two illustrations given—from photographs for which we are indebted to Mr. Arthur K. Moseley, Draftsman of the Yard—show, the first, the steamer *Uganda* on the ways; the second, the launch of that ship, which took place in April. Other wooden ships in progress are a duplicate of the *Uganda*, nearly completed, and a schooner to tow behind her. The latter was launched May 31; she is 240 ft. keel, 39 ft. 6 in. beam, 17 ft. 6 in. deep, and has four masts.

The *Uganda* is owned by James McBrier and others, of Erie, Pa.; she is expected to carry 2,400 tons of iron ore, or from 95,000 to 100,000 bushels of corn on 16 ft. draft. Her dimensions are: Length between perpendiculars, 290 ft.; length over all, 308 ft. 6 in.; beam, molded, 40 ft.; beam, extreme, 41 ft.; depth, molded, 23 ft. The engine is a triple-expansion, with cylinders 20 in., 32 in. and 54 in. × 42 in. stroke, and there are two boilers 11 ft. 6 in. in diameter and 12 ft. long, built to carry 160 lbs. pressure. The captain's cabin is very handsomely fitted up, and all the appointments of the ship are of the best kind.

The fame of this yard has extended beyond the lakes, and the sending of two freight steamers to the Atlantic Coast was noted some time ago. The firm has also just closed a contract to build a large steel tug for W. G. Wilmot & Company, of New Orleans, La. This boat will be 110 ft. long, 23 ft. beam, and 11 ft. extreme depth. The propeller will be four-bladed, 9 ft. 3 in. in diameter; the shaft will be 8 in., driven by a triple-expansion engine with cylinders 16 in., 24 in. and 40 in. × 28 in. stroke. The working pressure will be 160 lbs., and the piston speed about 500 ft. per minute The boiler will be 12 ft. 6 in. in diameter and 12 ft. 8 in. long. The main deck houses will be of iron, and the boat will have the latest improvements, including two steam capstans, steam steering gear, electric light plant with search light, a donkey boiler and Wheeler condenser. She will be specially adapted for the New Orleans towing service.

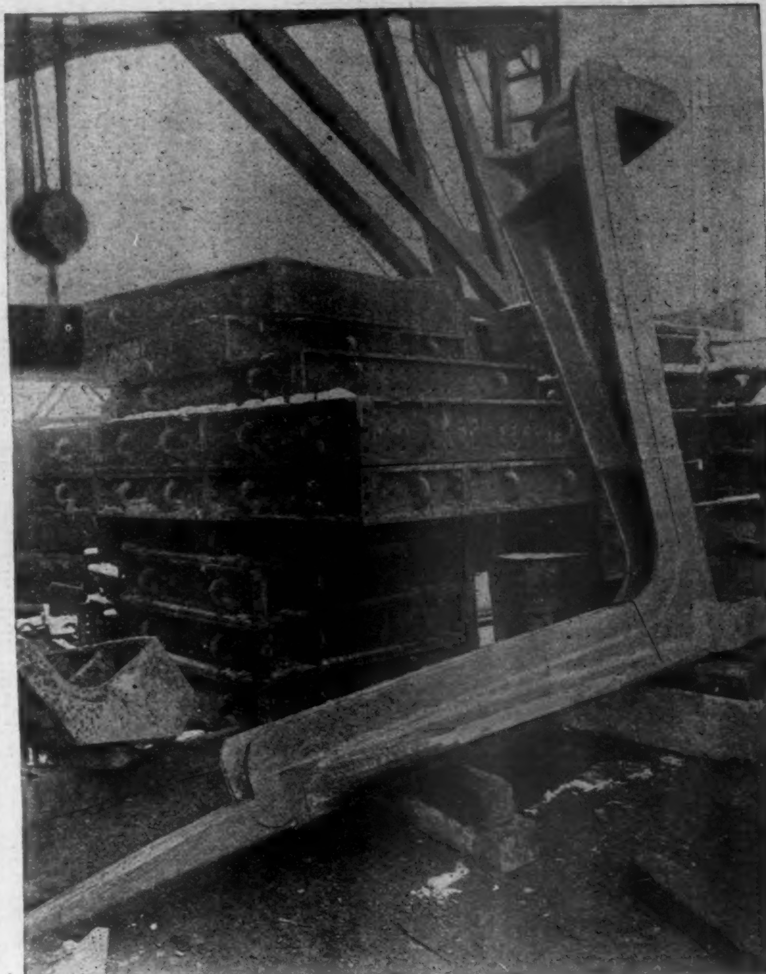
It is understood that the success of this tug will be followed by other orders from the sea-coast.

Foreign Naval Notes.

THE *Murature*, a torpedo boat built in the Thornycroft yards in London for the Argentine Republic, has made successfully the sea voyage from London to Buenos Aires, stopping at Lisbon, Las Palmas, St. Vincent, and Pernambuco. The voyage was an average one, the boat meeting some severe weather on the trip; the average speed was about 10 knots. It is said that this is the longest sea voyage ever made by a torpedo-boat. The *Murature* is 153 ft. in length by 14 ft. 7 in. extreme beam; and draws with 30 tons of coal on board, 3 ft. 9 in. forward, and 5 ft. 7 in. aft, inclusive of the heel guard, which is nearly 2 ft. below the body of the ship. She is fitted with twin screws and rudders, and can work either one or both engines at option, with either one or both boilers. Her highest speed with one engine is about 16 knots, and with both running at full speed she made on the trial trip 25 knots. She carries three torpedo-tubes, and has also three Nordenfelt rapid-fire guns.

Steel Castings for the Navy.

THE illustration herewith is from a photograph of the stern-frame casting for the United States Cruiser *Marblehead*, now under construction at Boston. This casting is remarkable, not only for its size—the weight when shipped being 9,213 lbs.—but for its peculiar shape. Notwithstanding these, the casting when made was an excellent one and free from defects. It was made at the works of the Midvale Steel Company, in Philadelphia, and not only fulfilled all the requirements of the Navy Department, but in some respects exceeded them.



STERN FRAME CASTING FOR CRUISER "MARBLEHEAD."

The specifications under which this casting was made required that a test bar ½ in. in diameter and 2 in. between measuring points should show tensile strength of 60,000 lbs. per square inch and 15 per cent. elongation; a cold-bending test was also required.

The official test showed tensile strength of 65,174 lbs.; 32.2 per cent. elongation, and 48.7 per cent. contraction. The tensile strength was thus 8.6 per cent., and the elongation 114 per cent. above the requirements.

A bar 1 in. square cut from the casting was bent cold at a right angle over a 3-in. round, without showing any signs of flaw or crack.

There has been some controversy lately over the Navy Department requirements for steel castings, but the results obtained in this case seem to show that they can be fully met.

The photograph shows the peculiar and difficult shape of the casting very well.

The use of steel castings in shipbuilding has given rise to much discussion, both in this country and in England, but the improvement in quality of material and excellence of castings promises to remove the doubts heretofore existing.

LOCOMOTIVE RETURNS FOR THE MONTH OF MARCH, 1892.

Name of Road.	Number of Serviceable Locomotives on Road.	Number of Locomotives Actually in Service.	Locomotive Mileage. Passenger Trains.	Locomotive Mileage. Freight Trains.	Locomotive Mileage. Service and Switching.	Locomotive Mileage. Total.	Locomotive Mileage. Average per Engine.	Av. Train. Passenger Cars.	Av. Train. Freight Cars.
Alabama Great Southern	61	54	51,931	77,508	36,893	166,324	3,080	....	....
Alabama & Vicksburg	18	14	17,778	14,422	9,831	42,031	3,002	....	....
Atchison, Topeka & Santa Fé	818	721	....	....	315,581	2,000,776	2,775	....	....
Canadian Pacific	591	...	490,419	877,417	275,102	1,642,938	2,780	....	....
Chic., Burlington & Quincy	504	....	....	....	....	1,774,928	3,522	5.33	17.54
Chic., Milwaukee & St. Paul	804	....	....	....	....	2,247,323	2,795	....	....
Chicago & Northwestern	846	....	667,175	1,335,642	607,759	2,610,576	3,086	....	....
Cincinnati Southern	106	100	80,840	172,374	73,640	326,854	3,269	....	....
Cleve., Cinn., Chic. & St. L.	....	463	453,672	674,830	371,483	1,444,985	3,239	4.20	20.50
Cumberland & Penn	....	22	4,674	25,601	....	30,275	1,376	....	....
D., L. & W., Morris & Essex Div.	156	...	167,038	254,228	12,039	433,305	2,778	....	....
Hannibal & St. Joseph	42	40	49,991	75,625	24,691	150,307	3,757	4.81	16.04
Kan. City, F. S. & Mem.	152	....	105,170	245,981	113,904	465,055	3,059	....	....
Kan. City, Mem. & Birm.	41	38	36,192	56,021	10,879	103,092	2,713	...	....
Kan. City, St. Jo. & Council Bluffs	44	41	59,024	46,058	39,831	144,913	3,537	4.86	20.74
Lake Shore & Mich. South	576	....	441,508	870,364	584,622	1,896,494	3,292	....	....
Louisville & Nashville	....	*344	435,332	813,525	383,233	1,642,090	3,663	5.04	15.83
Manhattan Elevated	....	290	788,514	....	66,967	855,481	2,950	..	....
Mexican Central†	146	119	....	....	....	368,917	3,100	....	....
Mil., L. S. & West	112	99	78,633	169,285	81,875	329,793	3,311	....	....
Missouri Pacific	339	310	....	....	....	1,133,033	3,654	4.31	17.15
N. O. & Northeastern	36	28	27,400	43,163	20,655	91,218	3,258	....	....
N. Y., Lake Erie & West	....	622	445,495	1,025,893	297,114	1,768,502	2,846	4.50	20.50
N. Y., Pennsylvania & Ohio	....	261	146,709	462,740	140,061	750,410	2,875	5.00	17.40
N. Y., Prov. & Boston	....	92	101,018	48,772	55,023	204,813	2,226	....	...
Norfolk & Western, Gen. Eastern Div.	....	131	98,792	232,745	69,418	400,955	3,061	4.30	19.30
Durham Division	....	6	7,182	10,146	1,710	19,038	3,173	5.50	3.40
Radford Division	....	52	16,492	114,255	9,191	139,938	2,691	5.10	17.10
Pulaski Division	....	27	27,171	48,731	7,599	83,501	2,783	4.70	11.90
Clinch Valley Division	....	41	20,750	56,497	17,539	94,786	2,312	3.70	10.10
Ohio & Mississippi	113	....	137,179	171,316	95,273	403,768	3,573	..	....
Old Colony	....	210	316,839	130,011	112,927	559,777	2,666	....	....
Philadelphia & Reading	....	....	452,711	824,044	551,384	1,828,139	....	....	....
South. Pacific, Pacific Sys.	....	701	....	....	....	1,587,405	2,264	....	....
Vicksburg, S. & P.	24	14	16,848	9,072	11,000	36,920	2,637	....	....
Wabash	393	347	406,688	707,610	251,031	1,365,329	3,915	4.85	18.27
Wisconsin Central	153	137	127,105	279,457	65,404	471,966	3,445	...	...

Name of Road.	Coal Burned per Mile. Passenger Train Mile. Lbs.	Freight Train Mile. Lbs.	Service and Switching Mile. Lbs.	Train Mile, all Service. Lbs.	Passenger Car Mile. Lbs.	Freight Car Mile. Lbs.	Cost per Locomotive Mile. Repairs. Cts.	Fuel. Cts.	Oil, Tallow and Waste. Cts.	Other Accounts. Cts.	Engineers and Firemen. Cts.	Wiping, etc. Cts.	Total. Cts.	Cost per Car Mile. Passenger. Cts.	Freight. Cts.	Cost of Coal per Ton. $
Alabama Great Southern	57.93	101.01	45.98	76.04	...	6.33	4.90	5.40	0.24	0.50	6.10	2.00	19.14	....	....	....
Alabama & Vicksburg	50.38	112.35	48.19	72.73	....	6.34	3.30	6.50	0.30	1.00	5.90	1.80	18.80	....	....	....
Atchison, Topeka & Santa Fé	...	....	....	83.44	....	....	5.77	6.90	0.28	0.16	6.32	1.82	21.25	....	....	1.58
Canadian Pacific	....	....	...	74.80	....	...	4.07	13.11	0.44	....	5 44	1.36	24.42	....	2.07	3.41
Chic., Burlington & Quincy	....	....	....	89.76	....	....	4.74	6.46	0.23	0.36	7.01	....	18.80	...	...	1.41
Chic., Milwaukee & St. Paul	....	....	....	78.06	....	.	5.08	7.84	0.28	....	6.97	....	20.17	....	....	1.95
Chicago & Northwestern	....	....	....	89.73	....	....	3.72	8.20	0.36	....	6.26	0.86	19.40	....	....	1.81
Cincinnati Southern	70.92	125 00	42.28	92.59	....	7.54	3.80	6.10	0.27	0.50	6.60	1.70	18.97	....	....	...
Cleve., Cinn., Chic. & St. L.	75.27	118.55	74.30	94.47	17.92	5.63	3.39	6.08	0.17	1.83	6.38	0.25	18.10	....	....	1.28
Cumberland & Penn	....	....	....	100.00	....	...	8.00	5.40	0.40	...	....	2.30	16.10	....	....	....
D., L. & W., Morris & Essex Div.	....	....	....	65.66	....	....	4.70	10.25	0.34	....	5.95	....	21.24	....	....	3.08
Hannibal & St. Joseph	....	...	....	87.41	17.89	6.46	3.78	5.70	0.15	0.27	6.52	...	16.42	....	....	1.40
Kan. City, F. S. & Mem.	....	....	....	67.66	....	...	3.16	5.87	0.21	0.44	7.31	....	16.99	....	....	1.68
Kan. City, Mem. & Birm.	....	....	....	67.43	....	....	3.17	4.04	0.80	....	6.93	....	14.94	....	....	1.15
Kan. City, St. Jo. & Council Bluffs	....	...	....	67.29	14.35	4.59	5.11	5.32	0.12	0.16	6.08	....	16.79	....	....	1.89
Lake Shore & Mich. South	63.47	90.83	35.71	67.68	....	....	3.11	5.43	0.18	....	6.94	0.19	15.85	....	....	1.59
Louisville & Nashville	64.10	112.45	48.23	83.93	12.79	6.86	5.00	6.78	0.26	1.42	6.11	0.64	20.21	3.41	1.54	1.62
Manhattan Elevated	....	....	....	46.62	....	....	2.80	9.40	0.30	....	8.70	....	21.20	....	....	4.03
Mexican Central†	...	....	....	66.35	....	....	5.53	16.55	0.41	0.16	5.88	0.95	29.48	....	....	5.60
Mil., L. S. & West	....	....	....	88.30	....	....	3.55	13.20	0.25	....	6.31	0.83	24.17	....	....	3.00
Missouri Pacific	....	....	....	96.24	19 02	6.92	5.46	6.51	0.33	1.38	6.44	1.46	21.58	4.52	1.45	2.28
N. O. & Northeastern	58.82	108.11	36.10	77.82	....	6.10	3.70	7.20	0.27	0.70	6.20	1.50	19.57	....	...	....
N. Y., Lake Erie & West	93.90	136.60	73.80	....	21.10	6.60	3.87	7.42	0.40	2.20	7.17	1.11	22.17	....	1 70	1.29
N. Y., Pennsylvania & Ohio	68.20	128.10	72 90	...	13.60	7.40	3.99	6.73	0.31	2.06	6.68	0.99	20.76	...	1.77	1.25
N. Y., Prov. & Boston	....	...	....	53.28	....	....	3.09	10.61	0.51	....	6.41	0.93	21.55	....	....	....
Norfolk & Western, Gen. Eastern Div.	...	....	....	102.04	....	....	6.80	4.20	0.80	....	....	....	11.80	....	....	....
Durham Division	....	....	....	60.61	...	....	1.90	8.50	0.40	....	....	....	11.80	....	....	....
Radford Division	....	....	....	137.93	....	...	10.20	5.60	0.80	...	...	....	16.60	....	....	....
Pulaski Division	....	....	....	105.82	....	....	5.60	4.30	0.70	....	....	....	10 60	...	....	...
Clinch Valley Division	....	....	....	125.78	....	....	10.50	5.20	1.10	....	...	....	16.80	...	....	....
Ohio & Mississippi	....	....	....	69.91	....	....	3.43	3.13	0.22	1.62	5.46	1.45	15.31	....	....	0.88
Old Colony	....	....	....	61.84	....	....	3.44	11.59	0.66	....	6.90	0.81	23.40	....	....	3.75
Philadelphia & Reading	....	....	....	89.97	....	....	4.85	5.04	0.30	....	5.76	0.40	16.35	....	....	....
South. Pacific, Pacific Sys.	....	....	....	67.18	...	....	5.90	18.47	0.36	1.68	7.29	1.90	35.60	...	....	5.67
Vicksburg, S. & P.	49.63	85.84	20.55	53.19	....	6.87	5.10	7.00	0.24	0.80	6.20	2.40	21.74	....	....	....
Wabash	68.98	109.47	57.00	....	14.49	6.05	3.12	5.27	0.29	....	6.18	0.85	15.71	2.82	0.97	1.20
Wisconsin Central	..	....	....	88.69	....	....	3.69	10.35	0.24	....	7.24	....	21.52	....	....	2.28

NOTE.—In giving average mileage, coal burned per mile and cost per mile for freight cars, all calculations are made on the basis of *loaded* cars.

* Number of engines in revenue service only; average mileage is also based on revenue service.

† The Mexican Central Railroad reports 16.3 units of work per $1 of expense; 169.2 units of work per ton of coal; 11.2 lbs. of coal per unit of work. The unit of work is 100 gross tons hauled one mile in one hour on a straight and level track.

Bending Rolls for Heavy Plates.

THE accompanying engraving shows a very heavy and powerful machine for bending plates, built by the Niles Tool Works at Hamilton, O. The machine is complete in itself, two upright two-cylinder reversing engines being placed on the bed-plate for driving the rolls and for raising and lowering them.

This machine has four rolls—two central rolls, one placed above the other, and two side rolls moving in inclines on either side, adjustable to suit the diameter to be bent.

The rolls are all solid wrought-iron forgings. The center rolls are 26 in. diameter, the side rolls 22 in. diameter. The center rolls are driven by a pair of reversing engines, running them in either direction. The side rolls are raised and lowered by an independent reversing engine. These rolls may be operated together or separately, or either end of either roll may be raised independently, as may be required.

The housings supporting the rolls are very strong and substantial. The journal bearings of the rolls are of very large diameter and fitted into bearings set into the housings.

The entire machine is mounted on a very heavy sole-plate provided with anchor-bolt holes to secure it to the foundation.

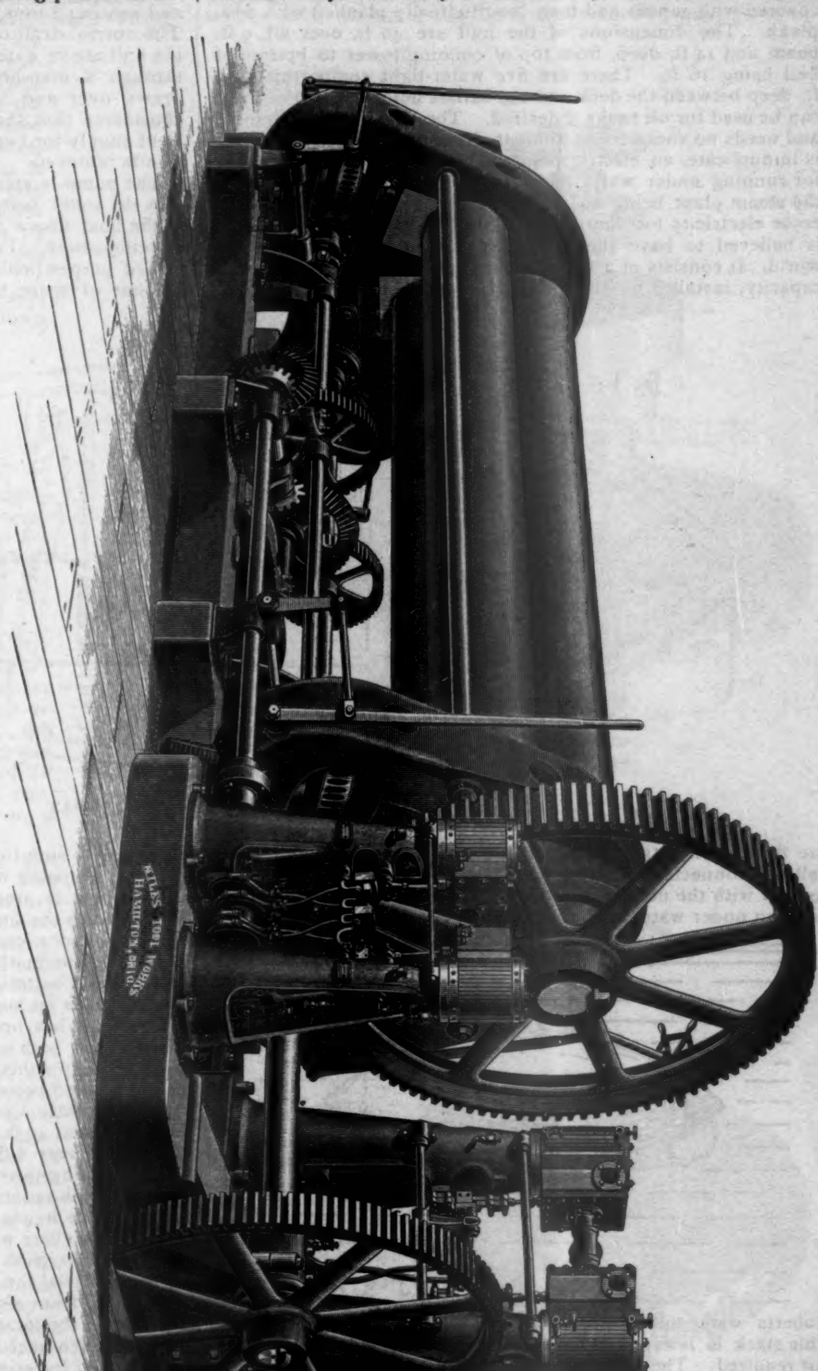
The machine will bend ship plates, curving them in any manner required, and has ample power and strength to do the work expeditiously.

A machine constructed in this manner, with four rolls, curves the sheet almost up to the edge, leaving only a short straight end. This is specially important when working heavy plates such as the machine will bend.

The machine is intended to be set in a pit, upon a solid foundation. All reversing and operating levers, etc., are brought above the floor line, which should be about the height of the cross-girt.

The machine shown in the cut—which is called by the makers No. 10—will bend plates up to 1½ in. thick and 16 to 22 ft. long. Two of them were recently built for the United States Government, and are now in use at the Norfolk Navy Yard, bending heavy plates.

The Niles Tool Works have also built a machine almost exactly similar in design, but somewhat larger and heavier, for the Mare Island Navy Yard in California. This machine—called No. 12—has four rolls 22 ft. 6 in. long, and will bend plates up to 2 in. in thickness; the rolls have an adjustment of 20 in. The main gear of this No. 12 machine is 10 ft. diameter and 15 in. face, the teeth having 5 in. pitch. The driving engine has two 12 × 16-in. cylinders, and the whole weight is 250 tons.



NO. 10 POWER BENDING ROLLS, BUILT BY THE NILES TOOL WORKS.

THE Baldwin Locomotive Works, Philadelphia, are building 10 heavy passenger locomotives for high speed on the Baltimore & Ohio Railroad. Another recent order is for 10 consolidation and 5 ten-wheel engines for the Norfolk & Western.

THE Falls Hollow Stay-bolt Company, Cuyahoga Falls, O., has recently received orders for its patent stay-bolts from the Michigan Central, the Delaware & Hudson Canal Company, the Long Island and the Manhattan Elevated Railroads.

The Baker Submarine Boat.

THE accompanying illustrations, from the Cleveland *Marine Journal*, show a submarine torpedo-boat devised by Mr. George C. Baker, of Des Moines, Ia. This gentleman has made a study of the subject for several years, and about a year ago ordered an experimental boat built by F. P. Ballin, of Detroit, Mich. This boat is shown in the cuts, fig. 1 being a section and fig. 2 a small sketch showing the general appearance of the boat under water.

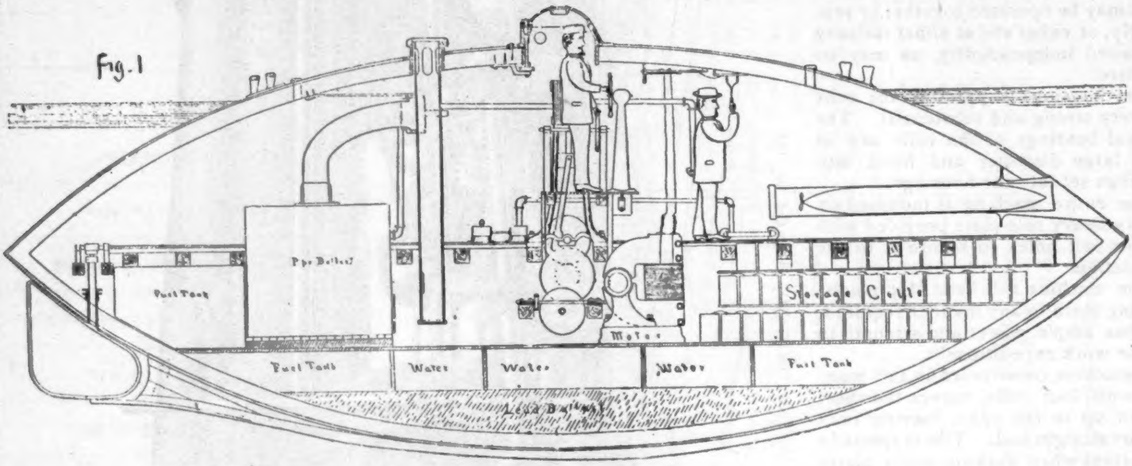
The construction of a hull to withstand the pressure at a depth

of 80 or 100 ft. was no easy problem, but it was solved by using 3-in. oak plank 6 in. wide sawed in cylindrical form, so that a number of pieces joined together made a frame, the frames diminishing in size from the center frame being bolted together so as to form the spheroidal hull. The longitudinal sections are parabolic and the cross sections ellipses. This hull was covered with canvas and then longitudinally planked with 2-in. plank. The dimensions of the hull are 40 ft. over all, 9 ft. beam and 14 ft. deep, from top of conning-tower to bottom of hull being 16 ft. There are five water-tight compartments 2 ft. deep between the deck and the ballast hold, but two of them can be used for oil tanks if desired. The boat is self-contained, and needs no shore connections to drive it. The driving power is in duplicate, an electric plant and a steam plant, the former for running under water and the latter for surface propulsion, the steam plant being so arranged that it can be used to generate electricity for charging the storage batteries. This boat is believed to have the largest storage battery plant in the world. It consists of 236 Woodward cells of 700 ampere hours' capacity, installed by Mr. H. H. Humphrey, of Detroit. They

and the boat answers to it readily. It will be understood by the foregoing description that such a boat would have no difficulty in running at the surface, but the following description of a descent will explain its submarine capabilities. The boat has about 75 tons displacement, the hull weighing 20 tons, the ballast 30 tons, the storage battery cells 10 tons, engine and boiler and gearing 8 tons, and motor 3 tons, leaving 4 tons buoyancy. The normal draft of the boat leaves about 2 ft. of the crown of the hull above water. The pilot and electrical engineer enter through a man-hole in the conning-tower, and the cover is drawn over and fastened when the boat is air-tight. If it is considered that the hull contains 1,500 cub. ft. of air, a sufficient supply for two men for 18 hours, the possibility of suffocation is removed.

The pump is started and two or three tons of water pumped into the water bottoms, this additional weight leaving nothing of the boat above the surface except the top of the hull and the conning-tower. To sink directly downward the wheels are turned perpendicular to the shaft and the motor started. The amount of spare buoyancy determines the amount of power

Fig. 1



THE BAKER SUBMARINE BOAT.

are divided into two parts and are worked in multiple. The cells are connected with a 50-H.P. Jenny motor, which is thrown in gear with the main shaft when it is desired to sink the boat and run under water. The steam plant consists of a $4\frac{1}{2} \times 5\frac{1}{2}$ ft.

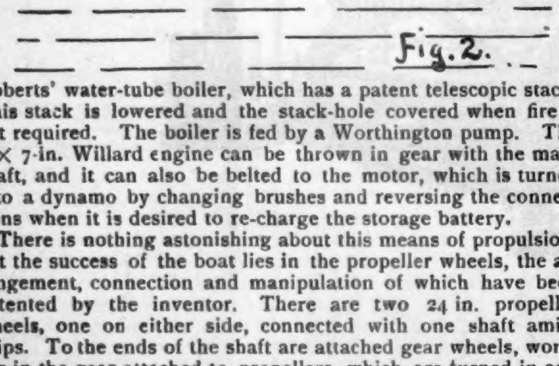


Fig. 2.

Roberts' water-tube boiler, which has a patent telescopic stack. This stack is lowered and the stack-hole covered when fire is not required. The boiler is fed by a Worthington pump. The 7×7-in. Willard engine can be thrown in gear with the main shaft, and it can also be belted to the motor, which is turned into a dynamo by changing brushes and reversing the connections when it is desired to re-charge the storage battery.

There is nothing astonishing about this means of propulsion, but the success of the boat lies in the propeller wheels, the arrangement, connection and manipulation of which have been patented by the inventor. There are two 24 in. propeller wheels, one on either side, connected with one shaft amidships. To the ends of the shaft are attached gear wheels, working in the gear attached to propellers, which are turned in any position by means of a sleeve around the shaft. This sleeve is connected to a hand-wheel with chain belting. By means of this hand-wheel the propellers may be placed in any position. The propellers are protected by brackets from coming in contact with any obstruction. The rudder fits close to the hull

necessary to sink the boat. When the desired depth is attained then the propeller wheels are turned at an angle of about 45°, and the boat is propelled forward, neither rising nor sinking. To ascend to the surface the machinery is stopped, and the reserve buoyancy causes the boat to rise. Any accident that would stop the machinery would also cause the boat to ascend. The storage batteries will run the boat three hours at a speed of eight miles an hour.

This boat has been repeatedly worked in the river Rouge, near Detroit, both on and under the surface, in water from 15 to 20 ft. deep; this has been done to test the working of the machinery and become familiar with the action of the boat.

More recently a test was made in the Detroit River with a depth of about 40 ft., a strong current and many boats passing, making it a very difficult place to operate such a craft.

The conning-tower was closed over the two occupants, Mr. Baker and his assistant, at 1.50 P.M., and remained closed until 4.35, in all 2 hours 45 minutes, in which time no unpleasant atmospheric effect was noticed. When the boat was opened the air seemed as fresh and invigorating as when at first closed. During this trial the boat was repeatedly submerged, disappearing entirely from sight and leaving no disturbance on the surface to note the location of the submerged craft. The boat retained its even keel beneath the surface and answered readily in rising and lowering to the requirements of the pilot. Altogether, the tests so far have been very satisfactory and will be continued from time to time until the full capacity of the boat is developed.

Some New Machine Tools.

The Philadelphia shops have for many years been noted for the excellent design and workmanship of their machine tools, and examples of their work can be found all over the country. The illustration given herewith shows a new tool from the works of Bement, Miles & Company, which are prominent in that city for the number and variety of the tools which they make.

The illustration shows a double-wheel lathe which will take in wheels up to 57 in. in diameter. The general construction will be readily understood from the engraving. The driv-

ing cone is so geared as to give eight changes of speed to one face-plate and four to the other. The face-plates can be driven together or separately, and at the same or different speeds, as desired. The feeds are variable and self-acting at all angles by an overhead rock shaft, actuated by slotted cranks at the end of the spindles. Each main spindle has an internal sliding spindle, with sufficient movement beyond the face-plates to swing driving-wheels on axles when the crank-pins are in place. The center line of the spindles is carried backward, so as to bring the cutting strains on the greatest diameters within the area of the bed; by this means the front slides are elevated to correspond with the curvature of the face-plates, increasing the strength of the bed where it is subject to the greatest strength. By this also the tool-rests are shortened, and are therefore stiffer. The advantages will be appreciated by those who have had occasion to use lathes of this class.

These tools are, it is hardly necessary to say, made and finished with the care which is shown with all work turned out from these shops.

The Arrowhead Dam.

In a pamphlet recently read before the Engineers' Club of Cincinnati, Colonel Latham Anderson described a dam about to be built by the Arrowhead Reservoir Company at Little Bear Valley, Cal.; the object is to store the waters of the Mohave River to irrigate a large district near San Bernardino.

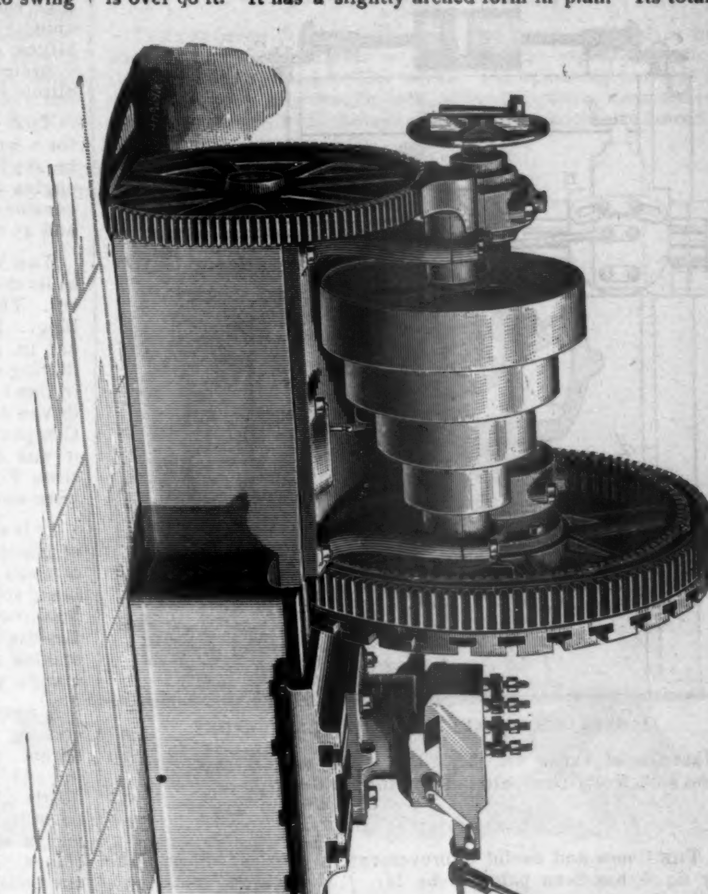
On account of the configuration of the valleys very short dams will be required, extending between the steep rock slopes of the cañon, on either side. The granite of which these slopes are composed forms excellent material for masonry, but the soil in the neighborhood does not afford material suitable for puddle; also, on account of the frequency of earthquakes in this part of the continent, it was considered unsafe to rely on a purely masonry dam.

To meet all the conditions, the following type of dam has been proposed by the writer: The water face of the dam to have a face of masonry on a slope of $\frac{1}{2}$ to 1 of a uniform thickness, to act as a retaining wall when the reservoir is empty. The thickness calculated for a dam 150 ft. high is 10 ft. This masonry is to have a dry backing 2 ft. thick, with the joints well filled with cement mortar 3 or 4 in. from the lower face. A tile underdrain is extended along the bottom of this wall with outlets under and across the dam, and discharging below its foot atregular in tervals of height. The dry wall thus acts as a drain to the masonry above it. This composite wall rests upon an earthen dam. Instead of being spread in layers in either of the usual methods, the earth, granite bowlders and gravel are piped into place by the hydraulic method. The wall is first carried up as high as it can be safely built on this slope without support. When a section of the wall is finished to this height the earth backing is filled in to within a few inches of the top of the wall. Another section of the wall is then built and another layer of earth filling piped in; this process being carried on to as high a level as it is practicable to pipe in the earth. It is expected to be possible to construct the dam in this manner to a height of 125 or 150 ft., above which level the earth filling will be made of the same material as below, but in one of the usual manners, probably with wire rope and trolleys. The lower slope will be kept in shape by dry stone facing carried up as the piping proceeds.

With water convenient, under a good working head, the earth can be filled in at from 4 to 5 cents per cubic yard. The upper portion, to be filled in by cable, will probably cost from 20 to 25 cents.

The wall is to be of concrete filled in with large blocks of granite, the joints in no case being less than 2 in. thick. The facing, 10 ft. thick, is to be of large blocks of granite rubble laid in cement mortar with $\frac{3}{4}$ in. joints. The material, including blocks of granite weighing four to five tons each, is to be distributed on the wall by wire rope and trolley.

The cañon has bare rock walls so nearly vertical that the dam is only 50 ft. long on the bottom and less than 200 ft. at the height of 125 ft. The thickness of the dam on the bottom is over 90 ft. It has a slightly arched form in plan. Its total



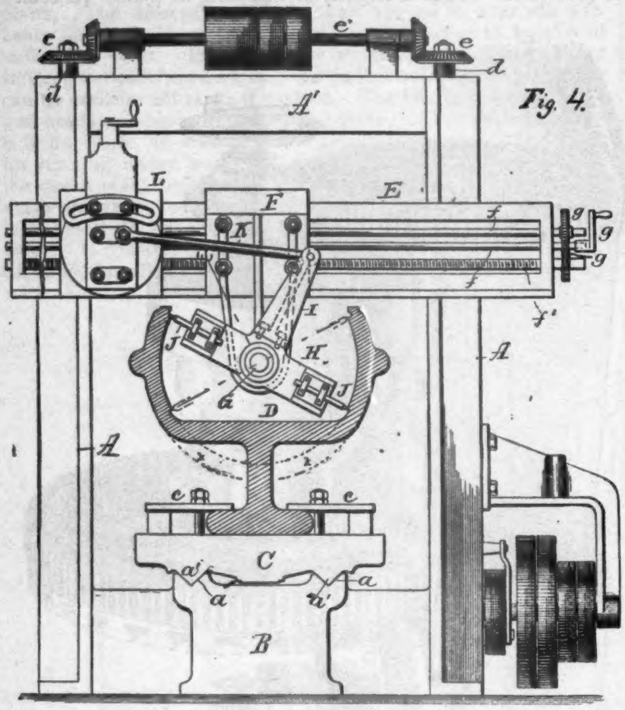
DOUBLE WHEEL LATHE BY BEMENT, MILES & COMPANY, PHILADELPHIA.

height is to be 150 ft. The upper 25 ft. traverses a long granite ridge after leaving the cañon. The plans, it is understood, are shortly to be carried out and the dam built.

Recent Patents.

MACHINE FOR PLANING CIRCULAR GUIDES FOR ENGINE BEDS.

THE engraving, fig. 4, represents a device for the purpose described in the title, which has been patented by Mr. Herman



HABERLIN'S PLANER FOR CIRCULAR GUIDES.

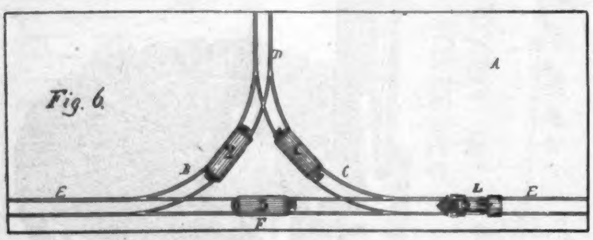
Haberlin, of Akron, O. The illustration makes the construction sufficiently clear without any further description.

RAILROAD PUZZLE.

THE "new and useful improvement in puzzles," illustrated by fig. 6, has been patented by Mr. J. C. Jackson, of Greenville, Pa.

The problem presented is to place the locomotive and cars as shown, run the locomotive around the Y to reverse it, and leave the cars as they were found—3 at *F*, 2 at *B*, and 1 at *C*.

In the solution of the problem what is known as "running switches" are not allowed. The cars can only be pushed or



JACKSON'S RAILROAD PUZZLE.

pulled by the locomotive. Neither can but one car or the locomotive alone be upon the spur *D* at one time. Neither can more than two cars or the locomotive and one car be upon the main track at the left of the Y, as at *E'*, at one time. The main track between the branches of the Y will hold the locomotive and one car.

The inventor's solution of his puzzle will be withheld until the August number of the JOURNAL appears.

An Electric Freight Railroad.—The Farmington & Doe Run Railroad is a short line now under construction from De Lassus Station, on the Belmont Branch of the St. Louis, Iron Mountain & Southern to the town of Farmington, Mo. It is $4\frac{1}{2}$ miles long and is laid with 52-lb. rails. It is to be operated by electricity, both passenger and freight cars being furnished with electric motors.

Manufactures.

General Notes.

THE E. P. Allis Company, in Milwaukee, is making the engine which will furnish the motive power for nearly all the machinery at the Exposition. This engine will be one of the largest ever built; it is of the quadruple-expansion type, and is expected to work up to about 3,500 H.P. The engine will constitute the chief part of the Allis Company's exhibit.

THE Chicago Ship-building Company has taken a contract for a large steel steamer for Buffalo parties. The vessel is to be 287 ft. long, 41 ft. beam and 24 ft. 6 in. depth of hold. The engine will be built by Trout, in Buffalo; it will be a triple-expansion, with cylinders 19 in., 33 in. and 52 in. in diameter and 45 in. stroke.

THE Wellman Iron & Steel Company now has in operation at its mills in Thurlow, Pa., the largest plate rolls in this country. The mill can turn out plates 126 in. in diameter and 70 ft. long. The rolls are 132 in. long, the top and bottom rolls being $34\frac{1}{2}$ in. in diameter and the middle roll 20 in. The engine driving the train is a Wetherill Corliss, with cylinder 40 × 60 in., and a fly-wheel 25 ft. in diameter. The table rollers are driven direct by a double horizontal engine made by the Crane Company, of Chicago. This mill has many improvements; it was designed by Mr. S. T. Wellman and built by the Garrison Foundry Company, of Pittsburgh. The heating furnaces were also designed by Mr. Wellman.

IT is stated that the stock of the Pratt & Whitney Company, of Hartford, Conn., which is so well known as a manufacturer of tools and of gauges and other instruments of precision, has been sold to an English syndicate. The capital stock is $600,000, and the dividends last year amounted to 15 per cent. Besides its regular tool business, the Company has contracts for making the Hotchkiss and the Gardner rapid fire guns, and has made a great deal of gun-making machinery.

A LARGE addition is being erected to the assembling and erecting shop of the Westinghouse Machine Company, in Pittsburgh. The structure is of brick, 50 × 265 ft., and displaces the old erecting shop which was 30 × 265 ft., and in which nearly 5,000 engines were built and tested. The new shop will be 30 ft. high inside and well lighted by means of 3,000 square feet of skylight, and will be equipped with two 10-ton power cranes. Additional boiler capacity of 250 H.P Babcock & Wilcox boilers is being erected to be equipped with Roney stokers. The Company's business has outgrown the old capacity and the additions are undertaken to provide for an increased number and larger sizes, designs being now under way for 1,000 H.P. engines. April sales of Westinghouse engines amounted to 3,185 H.P., and those for May to nearly the same amount.

THE Brown & Sharpe Manufacturing Company, Providence, R. I., has recently brought out a new milling machine for heavy work, which is called No. 8. This machine takes up a floor space of $114\frac{1}{2} \times 68\frac{1}{2}$ in., and weighs about 5,000 lbs. The table is heavy, 66 in. long, 16 in. wide, having a working surface 54 in. long and a bearing in saddle 40 in. in length. It has three T-slots running the entire length between the pans at end of same. It may be lowered $19\frac{1}{8}$ in. below the center of spindle, and has an automatic feed of 48 in. and an adjustment in line with spindle, of $9\frac{3}{4}$ in. Milling may be done 21 in. from face of column, and cutters 16 in. diameter may be used. The cone has three steps (the largest $13\frac{3}{4}$ in. diameter) for $4\frac{1}{2}$-in. belt. The back gearing is $8\frac{1}{8}$ to 1, thus giving, with the two speeds provided on countershaft, 12 speeds for spindle. The feed cones have two steps, and by transposing these and changing the feed gears, eight changes of feed from 0.02 in. to 0.25 in. to one revolution of spindle may be obtained in either direction. The overhanging arm is of steel $4\frac{3}{4}$ in. diameter, and may be rigidly connected to the knee by an improved arm brace, which is readily adjustable and has a bearing for the outer end of arbor, thus allowing the usual arbor support to be used at any intermediate point near the cutter to counteract the tendency of the arbor to spring under heavy cuts. The vise has jaws $7\frac{1}{8}$ in. wide, $1\frac{7}{8}$ in. deep, and will open $4\frac{1}{2}$ in. The machine is adapted for a wide range of work.

THE Union Dry Dock Company, Buffalo, N. Y., recently launched the steamer *Codorus* for the Anchor Line. The new steamer's dimensions are as follows: Length over all, 290 ft.; length of keel, 275 ft.; beam, 40 ft.; molded depth, 26 ft. Two steel boilers of the Scotch type, each 12 ft. in diameter and 14 ft. long, built by the Lake Erie Boiler Works will supply power at 160 lbs. pressure, to a triple-expansion engine of H. G.

Trout's make, with cylinders of 20½, 33 and 54 in. in diameter, with 45 in. stroke. H. G. Trout also made the propeller wheel, which is 12½ ft. in diameter with 17½ ft. pitch. The *Codorus* will carry 3,000 tons on a draft of 15½ ft., and is expected to make 13 miles an hour with a full load.

THE American Steam Barge Company has, it is understood, made arrangements with an English company—William Johnston & Company, Limited—for the building of "whalebacks" for the Atlantic trade. The Cleveland *Marine Review* says of this arrangement: "Capitalists in the Barge Company here, chief among whom are John D. Rockefeller, Colgate Hoyt, and Joseph H. Colby, will, of course, be interested in the English company, but as yet the plans have not matured sufficiently to warrant very much being said of its success. The Johnston Line has a weekly boat from London to Boston, and from both Liverpool and London to Baltimore the service is also weekly. Close business relations with the Baltimore & Ohio Railroad is a feature of the Company's success in this country. Its business is not confined to boats running from Baltimore and Boston, but extends to all principal ports in Canada, Nova Scotia, and New Brunswick and to the Black Sea. The Company is one of the leading shipping concerns in England, and if the barges can be adapted to ocean service, the American owners of the patents have undoubtedly formed a sound connection abroad. It is intended to build oil-tank barges of the whaleback type for the Black Sea trade.

"Captain Alexander McDougall is now at Everett, the new barge town on Puget Sound, where two steamers are under way. It is very probable that marked changes will be made in the bows of the steamers for the Pacific Coast trade, as it has been shown in the case of the *Wetmore* that the present form of bow is a weak part of the vessel, especially when running light, and additional water ballast space forward will hardly remedy this defect."

THE annual meeting of the Consolidated Car-Heating Company was held at Albany, N. Y., June 6. The affairs of the Company were found to be in a prosperous condition, with excellent outlook for future business. A semi-annual dividend of 1½ per cent. was declared, payable August 15, transfer books to close August 1. Vice-President William C. Rice reported sales had averaged over $1,000 for every working day of past year. This included product of Canadian factory at Coaticook, P. Q. The Sewall steam coupler and improved (McElroy) commingler were reported as being used by many leading railroads of the country, having a mileage of 45,071 miles and 11,204 passenger cars. During the year 16,471 of these couplers have been sold. Officers were chosen as follows: President, Robert C. Pruyn, Albany; Vice-President and Treasurer, William G. Rice, Albany; Secretary, Charles J. Peabody, South Orange, N. J.; General Manager, Daniel D. Sewall, New York; Mechanical Superintendent, James F. McElroy, Albany; Assistant General Manager, James H. Sewall, Chicago. The following is the Board of Directors: Robert C. Pruyn, William G. Rice, Charles J. Peabody, D. D. Sewall, James F. McElroy, James H. Sewall, George Westinghouse, Jr., R. C. Blackall, H. A. Osgood, Albion Little, Charles Tracey, C. A. Jackson, George L. Walker, A. S. Hatch, and Anthony N. Brady.

After the election a visit was paid to the large new factory of the Company just completed in Albany.

THE Schenectady Locomotive Works have nearly completed an order for 27 engines for the Southern Pacific Company. All of these are two-cylinder compounds; seven of them are ten-wheel engines for passenger service, and the other 20 are twelve-wheel engines for freight service on the Mountain Division.

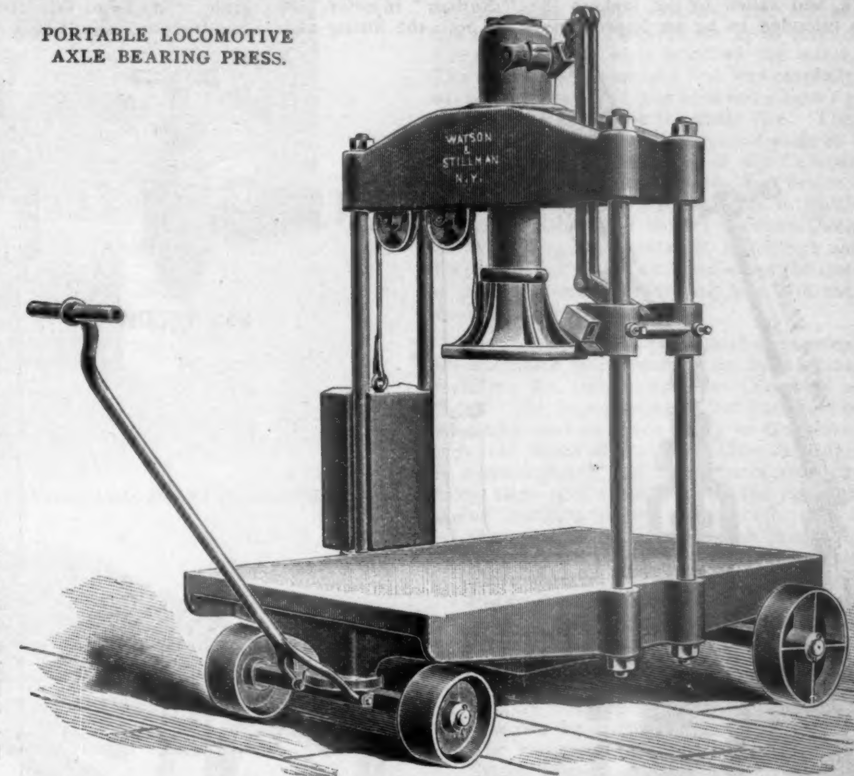
THE Cooke Locomotive Works, Paterson, N. J., are building six passenger engines with 19 × 24 in. cylinders for the Delaware, Lackawanna & Western; three passenger engines with 18 × 24-in. cylinders for the Evansville & Terre Haute; one passenger engine with 18 × 24-in. cylinders for the Lehigh & Hudson. They have just completed an order for 22 ten-wheel engines with 19 × 24-in. cylinders for the Houston & Texas Central.

A Portable Axle Bearing Press.

THE cut herewith shows a new style of press intended to be used for forcing the brasses in and out of the boxes of locomotive axle bearings and similar work. The operating power is a 20-ton base style hydraulic jack of special make, mounted in the upper platen, with the cylinder and base counterbalanced; and as the operating lever in a regular jack would be too high for convenient manipulation, a special jack is used and a new device is attached to the rods, and at this position the jack is operated the same as it would be at the jack proper. The movement is 12 in., and the full opening between the lower platen and the bars is regularly 18 in. The lower platen is made 30 × 48 in., and has a hole 4 in. in diameter through its center for forcing work through it when the plug which fills it is removed. The counterweight is so situated that it is not in the way, and is held in place when moving the press around the shop. The truck wheels are 7 and 10 in. in diameter by 3 in. face in the press shown, but any size of platen, height or power, can be made to order.

Patents have been applied for on this tool, which is made by the firm of Watson & Stillman in New York.

PORTABLE LOCOMOTIVE AXLE BEARING PRESS.



Some Uses of Graphite.

A CORRESPONDENT of the *American Machinist* says: "If engineers, machinists and millwrights in general, and pipe-fitters in particular, knew of the good qualities of graphite, I dare say there would be ten times the demand for it. Its lubricating qualities are questioned only by the impractical; and it is this quality alone that sounds its key-note, so to speak. Let me describe a few of what I consider its most important uses. As above stated, its primary object is lubrication, and it is to this fact we must credit good pipe joints and cool bearings. In making pipe cement (or, as I would term it, pipe smear), it is not necessary to use the best oil or grease, as it is the graphite and not the body in which it is suspended that makes the mixture valuable and the joint perfect. I use the drippings from line shaft bearings caught in the ordinary way, and mix it with the best Ticonderoga flake graphite, so that it can be applied with an ordinary sash tool.

"During the past three years I have used about 15 or 20 pounds of dry Ticonderoga flake graphite for pipe joints, cylinder heads, piston rod packing, etc.

"Bolts smeared with graphite mixed as above, I have unscrewed after having been in the dampest places for upward of two years or more, proving the anti-rusting qualities of graphite. To cool hot bearings, put it on as thick as it will mix with oil.

"Almost any oil or grease will answer, but don't use poor graphite."

A New Injector.

THE drawings given herewith show a new pattern of injector introduced by the Nathan Manufacturing Company of New York, and called by the makers the "Nathan" injector. It was intended to be an improvement on both the lifting and non-lifting instruments now in use, combining the best qualities of each. It is a self-contained instrument, comprising within itself the steam and water valves necessary for stopping, starting and regulating, and on a locomotive must be placed so that operating-rods can be carried into the cab.

A modified type is also made with detached starting and water valves, which will be found convenient in some cases, although the other type is considered preferable.

This injector must be placed below the lowest level of the water in the tank, so that the water will flow to it, but, unlike other injectors so placed, it is provided with a priming jet, and—this being a particular and novel feature, protected by patent—the overflow is placed above the highest water level in the tank, convenient to the engineer in the same manner as in a lifting injector, connecting with the overflow space in the injector body by means of a single piping, which can be applied and located in any convenient manner.

The advantages of the improvements made in this new pattern of injector can be appreciated from a careful study of the engravings. It may be added that it can be graded 50 per cent., making it suitable for light as well as for heavy work.

THE NEW "NATHAN" INJECTOR.

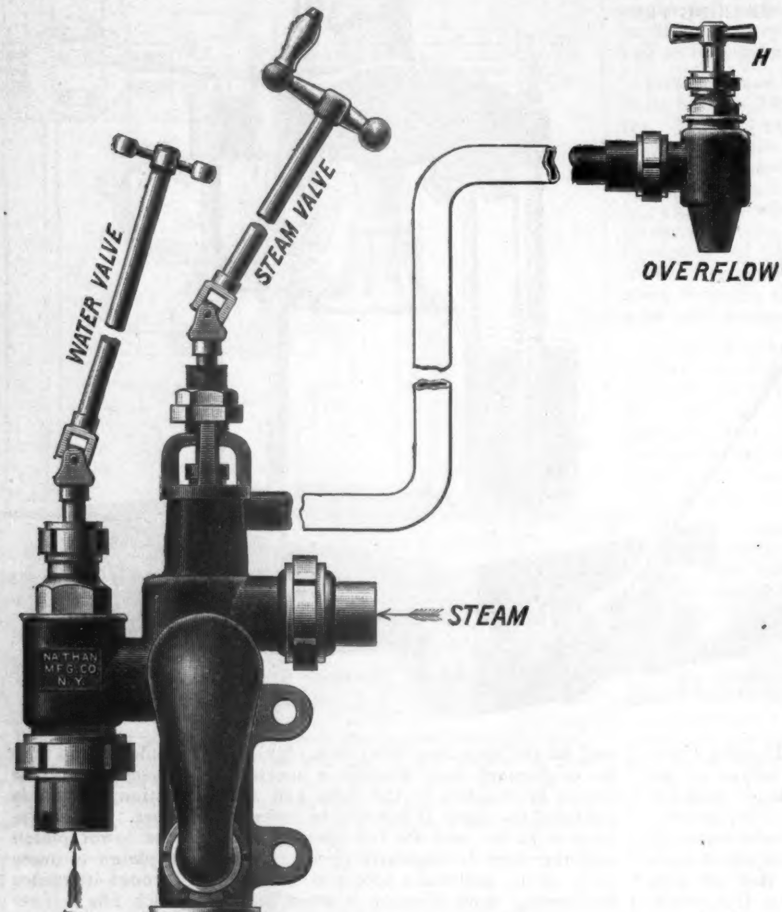


FIG. 1.—FRONT VIEW.

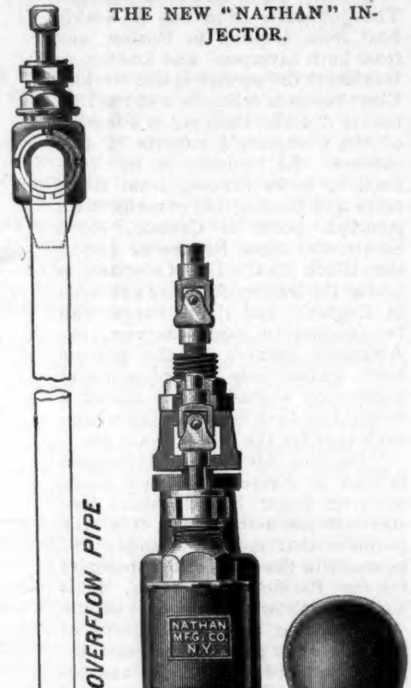


FIG. 2.—SIDE VIEW, SHOWING OVERFLOW PIPE.

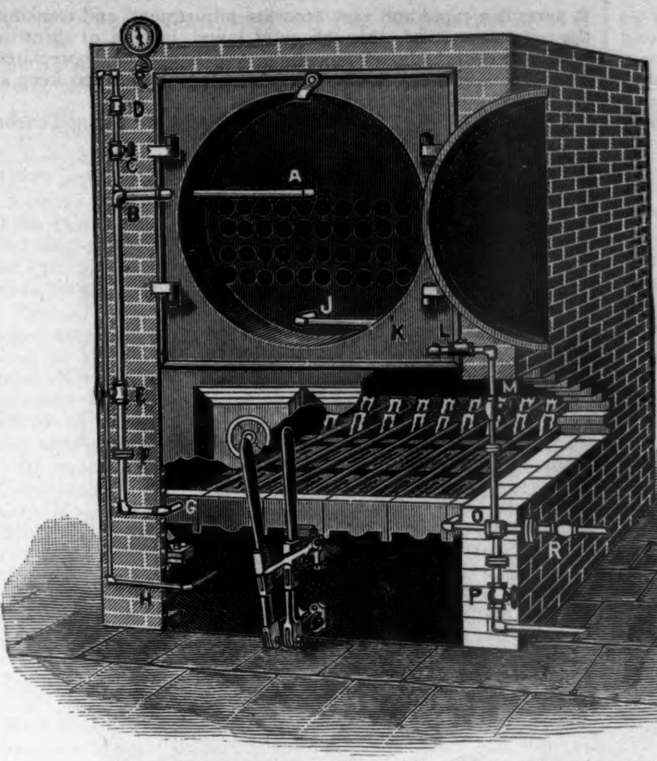
A New Grate.

THE drawings herewith show a form of grate with which very good results have been obtained in stationary boilers; fig. 1 shows a boiler fitted with the grate, and fig. 2 shows a grate ready to go into the boiler. The illustrations show the construction so fully that little description is needed.

It will be seen that it is in effect a combination of a water-grate with a shaking grate, the object being to combine the advantages of both forms. The water-tubes run longitudinally, connections being made at the ends. The connections between the grate tubes and the boiler are shown in fig. 1; by these a constant circulation is kept up through the water-tubes, which are thus prevented from burning out, and also serve as an efficient heater for the feed-water. The shaking-bars placed between the water-tubes are worked by the levers placed in front of the ash-pit, and serve to clean the fire. When they are properly used a good fire can be kept up with but little trouble, even with inferior coal.

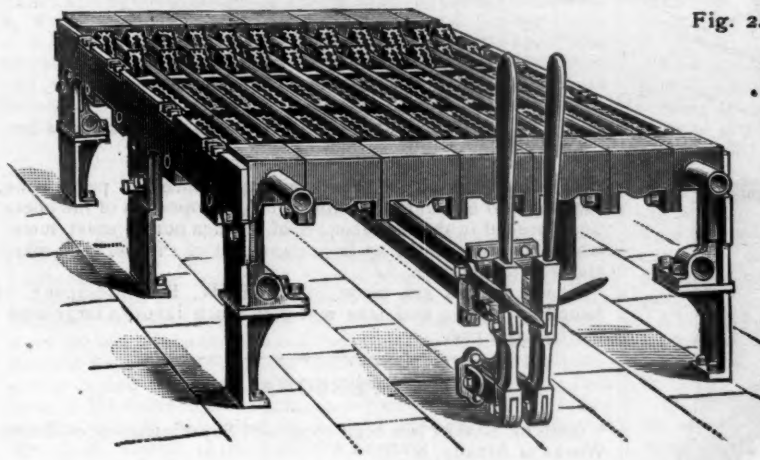
This grate has been under the test of actual use under a number of stationary boilers for a considerable time. The results have been very favorable, engineers who have used it reporting that it works very well, permitting the use of slack and other cheap grades of coal; less labor is needed to keep

Fig. 1.



REAGAN'S WATER-CIRCULATING AND SHAKING GRATE.

Fig. 2.



fires clean; no repairs are needed, and there is little or no deposit or scale.

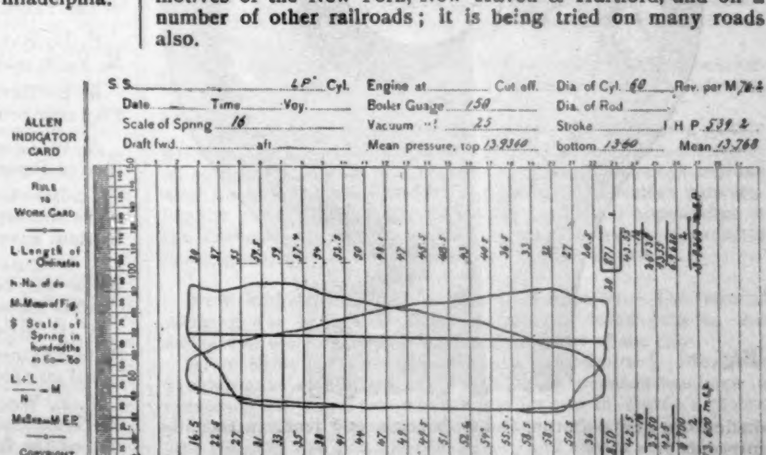
The advantages claimed will be readily appreciated. This grate is made by James Reagan & Company, of Philadelphia.

The Allen Indicator Card.

THE accompanying diagram shows a new and very convenient indicator card for the use of engineers. The diagram is reduced in size, the card being actually $7\frac{1}{2} \times 4$ in.; the illustration shows so well the method of use that but little description is needed.

The card is made to take the place of the ordinary plain card, and is provided with a scale and machine divided perpendicular lines or ordinates. The scale on the left-hand side of the card is arranged to suit any pressure spring, and consequently there is no need of any scales other than that on the card.

The directions for working are: "After diagram is taken on card, take all perpendicular lines or ordinates within diagram. Measure with dividers on scale and place result opposite each line, as shown on illustration. Add the total number of ordinates taken, multiply result by scale of spring in hundredths—as scale $16 = 0.16$, scale $32 = 0.32$. Multiply result by 2; answer = effective pressure of steam on piston."



These cards are published by the firm of Williamson & Cassedy in Philadelphia.

Baltimore Notes.

ONE set of engineers are surveying a line for the Baltimore & Cumberland Railroad from Cumberland down to Hagerstown, and another set has started from Hagerstown up to meet them. They are running what is called the water line. The interior or mountain line was carefully surveyed last year, and it is believed a better grade can be obtained along the water line. The new survey will probably be completed early in July. President T. B. Kennedy, of the Cumberland Valley Road, which runs from Winchester, Va., northeast to Harrisburg, Pa., was in Baltimore yesterday consulting with President Davis, of the West Virginia Central & Pittsburgh and the Baltimore & Cumberland, to discuss the question of making connection for his line with the new road at Hagerstown.

THE Baltimore & Ohio Company is preparing for extensive improvements on Staten Island to facilitate the freight business that will center there. The improvements that have just begun will take two or three years to complete, and will cost about $1,500,000. The developments in contemplation are the construction of new ferry slips and stations from the rapid transit trains running along the north and south shores from St. George. An immense new freight yard is to be established capable of accommodating 1,500 cars, with about 25 tracks running into it. The present ferry slips at St. George will be torn down to be replaced by two covered freight piers 500 ft. in length. The piers will be used for storing and handling freight. The docks will accommodate the largest ocean steamers, and vessels can be discharged directly into the cars. The company owns a large water front on Staten Island, and these improvements are but the beginning of extensive facilities that will be needed to meet growing demands.

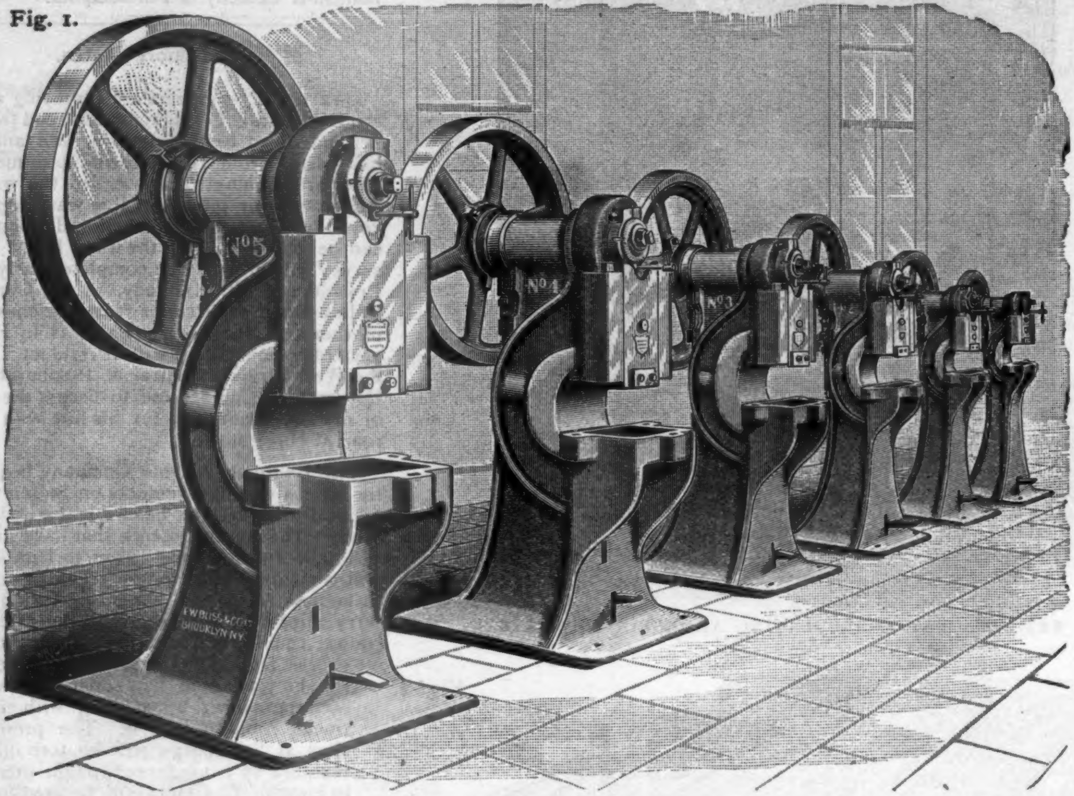
THE Cleveland & Western Railroad, which is about 20 miles long, and runs from Worcester to Lodi, on the Chicago & Akron Branch of the Baltimore & Ohio, has passed into the ownership of the Baltimore & Ohio.

THE Universal Automatic Lubricator Company has been reorganized under the name of the Automatic Lubricator Company; the office is at No. 18 Broadway, New York, and Mr. John A. Wyman is Superintendent. The lubricator pad is now in regular use on all the locomotives of the New York, New Haven & Hartford, and on a number of other railroads; it is being tried on many roads also.

The Stiles Power Punching Presses.

THE illustration given herewith shows a group of the Stiles punching presses of six different sizes, from No. 5, the largest, down to No. 0, the smallest made. These presses are now made from new patterns, and with some new features recently introduced.

Fig. 1.



STILES POWER PUNCHING PRESSES.

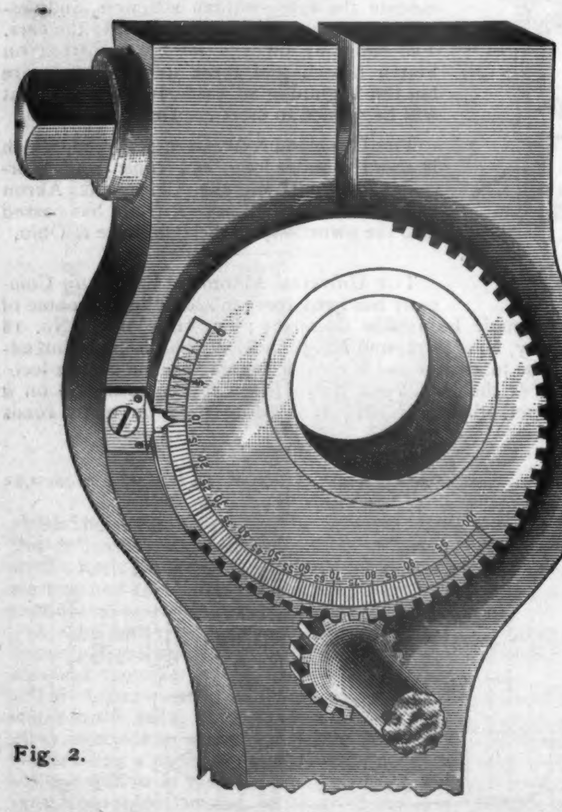


Fig. 2.

The eccentric adjustment used will be understood from fig. 2. It permits a rapid and very accurate adjustment, and transmits the pressure entirely through solid metal, instead of throwing upon screw threads, an advantage which will be appreciated. The graduation on the face enables the operator to keep an exact record of the setting of the dies.

The range of work for which these presses are adapted covers nearly every kind of blank-cutting, punching, perforating, forming and bending, including a large proportion of the operations needed in the manufacture of articles out of sheet metal, which now form such an important part of the work on many classes of machines.

These presses are made by the E. W. Bliss Company, of Brooklyn, N. Y., and have met with much favor, a large number being in use.

PERSONALS.

GEORGE BAILEY has been appointed Superintendent of Water Works at Albany, N. Y.

L. S. THORNE has been appointed General Superintendent of the Texas & Pacific Railroad.

MAJOR S. B. WATHEN has been appointed Resident Engineer of the Texas & Pacific Railroad

P. H. BAERMANN has been appointed City Engineer of Troy, N. Y., in place of C. L. FULLER, resigned.

R. H. BETHEL, formerly of New York, has been appointed Engineer of the Chicago Terminal Commission.

A. W. GIBBS has resigned his position as Superintendent of Motive Power of the Central Railroad of Georgia.

THOMAS C. CLARKE is the Engineer appointed to prepare the plans and supervise the construction of the new bridge over the Harlem River at Third Avenue, in New York City.

J. J. ANDERSON, for some time past in charge of the Macon shops, has been appointed General Master Mechanic of the Central Railroad of Georgia, with office in Savannah.

W. H. BRYAN, who for some time past has been with the Pond Engineering Company, has left that company and established an office of his own in the Turner Building in St. Louis.

M. E. WALLACE, for some time past Mechanical Engineer of the Gould Coupler Company, has been appointed Chief Draftsman at the Aurora shops of the Chicago, Burlington & Quincy Railroad.

C. H. PLATT has been appointed General Superintendent of the New York, New Haven & Hartford Railroad. He has been for some time General Manager of the Grand Central Station in New York.

JOSEPH H. FRANKLIN, late Station-master, succeeds Mr. C. H. Platt as General Manager of the Grand Central Station in New York. His jurisdiction includes the road to Mott Haven Junction and the Mott Haven yards.

SAMUEL REA has been appointed Assistant to the President of the Pennsylvania Railroad Company. He is a well-known civil engineer, and has been at different times connected with the Pennsylvania itself and with other important lines. For some time past he has been a resident of Pittsburgh.

THOMAS URQUHART, who has for a number of years been Superintendent of Motive Power of the Grazi-Tsaritzin Railroad in Russia, has been appointed General Manager of the great Nevski Works, in St. Petersburg, which manufacture locomotives and machinery of all kinds. Mr. Urquhart is well known as a frequent contributor to technical journals; he has also conducted many interesting experiments with locomotives.

ON account of the development of his private practice as Consulting Bridge Engineer, J. A. L. WADDELL, of Kansas City, Mo., has resigned the western agency of the Phœnix Bridge Company and the Phœnix Iron Company, which agencies he has held since January 1, 1887. His resignation takes effect July 1. A. C. STITES, who has been Mr. Waddell's principal assistant for four years, will take the agencies of the two companies, with headquarters at 121 Laclede Building, St. Louis. Mr. Stites will also take charge of a branch engineering office for Mr. Waddell, whose main office will still be at Kansas City.

E. M. HERR, recently Master Mechanic in charge of the West Milwaukee shops of the Chicago, Milwaukee & St. Paul, has been appointed Superintendent of the new Grant Locomotive Works in Chicago. He has an excellent reputation as a shop manager, and has had much experience. His staff includes some very good men; among them, as Chief Draftsman, R. RYAN, recently of the Chicago, Burlington & Quincy shops at Aurora; as Foreman of the machine and erecting shops, PETER ARNOT, who was in the old Grant Works at Paterson, and who is a most capable mechanic and foreman; and as Foreman Blacksmith, G. CASE, also of the old Paterson shops, and a man of much experience in his department.

OBITUARIES.

L. W. TOWNE, who died in Kansas City, Mo., May 14, was at one time an engineer on the Chicago, Burlington & Quincy Railroad, and later was made Master Mechanic of the Quincy Division of the same road. In 1866 he was appointed Master Mechanic of the Hannibal & St. Joseph Railroad, and afterward became Assistant General Superintendent. He was later General Superintendent of the Atchison & Nebraska Railroad, and occupied the same position with the Kansas City, Fort Scott & Memphis Railroad, when forced to retire from active service through continued ill health. He was a brother of Mr. A. N. Towne, of the Southern Pacific.

LEWIS MORRIS RUTHERFURD, who died at his residence at Tranquility, N. J., May 30, aged 75 years, was one of a class which the conditions of life have made rare in this country. Inheriting a sufficient fortune to relieve him from the necessity of working for a support, he devoted himself entirely to scientific pursuits. He was born in Morrisania, N. Y., and studied law, but gave up that profession for the study of physical science, especially astronomy, in which he attained considerable eminence. He was a leader in astronomical photography and spectral analysis, and published a number of valuable papers on those subjects. He devised and constructed a number of improvements in telescopes, and about 1870 made a ruling engine capable of cutting 17,000 lines to the square inch. This has never been surpassed, except, perhaps, by the one lately completed by Professor Rowland in Baltimore.

SIDNEY DILLON, who died in New York June 8, aged 80 years, was born in Montgomery County, N. Y. His parents were poor, and at 10 years of age he began work as a waterboy for a gang of laborers on the old Mohawk & Hudson Railroad. Gradually rising as he grew older, and accumulating some money, he started at last as a contractor on his own account. He built sections of the Western, now the Boston & Albany, the Hartford, Providence & Fishkill, and other roads in New England, and part of the Central Railroad of New Jersey. He built the Fourth Avenue improvement in New York, by which the track of the Harlem Railroad was placed either below or above the street grades from Forty-second Street to the Harlem River. His most extensive work was on the Union Pacific Railroad, a large part of which he built. He owned a large interest in the stock of the company, and was its President for a number of years.

Of late years Mr. Dillon had retired from the construction business, although he had been actively engaged in the management of railroad properties in which he was an owner. He had generally been allied with the Gould interest in the Union Pacific and other roads. He leaves a large fortune, chiefly invested in railroad securities.

PROCEEDINGS OF SOCIETIES.

American Society of Civil Engineers.—At the regular meeting in New York, June 1, a paper by Mr. H. H. Quimby on Wind Bracing in High Buildings was read and discussed at some length.

A paper by Professor A. J. Du Bois on a New Formula for Strength of Columns was read and discussion postponed.

The following elections were announced:

Members: Jean Pierre Ferriere, Blida, Algeria; William L. Marshall, U. S. Engs., Chicago, Ill.; Robert K. Martin, Baltimore; David A. Poynor, Dallas, Tex.; Charles Walker Raymond, U. S. Engs., Philadelphia; Horace See, New York; Charles Edwin Wells, Chicago.

Associate Members: Julius Baier, St. Louis; Griffith M. Eldridge, Americus, Ga.; Harry Hardy, Tabasco, Mex.; August Mayer, Los Angeles, Cal.; John Van Wicheren Reynders, Steelton, Pa.; Elmer Wayland Ross, Providence, R. I.; Louis L. Tribus, New York.

Associate: George Hervey Ely, Cleveland, O.

Juniors: George T. Barnsley, Dingess, W. Va.; Shirley Carter, Baltimore; James H. Edwards, East Berlin, Conn.; Charles H. Jewett, Julius A. Ludwig, New York; Robert E. Neumeyer, Bethlehem, Pa.; William H. Penn, New Britain, Conn.; Gabriel C. Tuthill, Detroit, Mich.

THE annual convention, at Old Point Comfort, Va., began June 8, a large number of members being present. Those attending from New York and the East generally reached the place of meeting by a special train, which left New York on the previous day, running by way of Wilmington and Cape Charles. On the first day three sessions were held, which were generally devoted to the reading and discussion of papers. At the evening session, President Cohen delivered his annual address. This was chiefly historical, beginning with the early history and conditions of the city of Baltimore which led up to the building of the Baltimore & Ohio Railroad, in which Mr. Cohen did his part.

Thursday, the second day of the convention, was spent in excursions, members being taken by steamboat to Norfolk to the Navy Yard, and thence by rail to Virginia Beach, returning in the evening.

On the third day morning and evening sessions were held, the morning one being a business meeting. In the afternoon members visited Fortress Monroe, where a special artillery practice was given for their benefit, and the work in progress on the fort in charge of the Corps of Engineers was inspected.

Saturday was chiefly taken up by a visit to the great yards of the Newport News Ship Building Company. In the evening the usual annual banquet took place, at which most of the members attending the convention were present, and a number of speeches were made.

On Monday, the last day of the Convention, a final session was held for reading of papers and discussions, and the convention adjourned.

While a number of interesting papers were presented at this convention and there were some excellent discussions, no action of special importance was taken. There were some discussions over the new rules adopted by the Board of Directors concerning the publication of papers in advance of their appearance in the Transactions, but no decisive action was taken, the matter being practically left to the discretion of the Board.

New England Water-Works Association.—The annual meeting was held in Holyoke, Mass., beginning June 8. An address of welcome was made by the Mayor of the city.

After some new members had been admitted, President Holden gave an address. He said the Association has been in existence ten years, and when it was formed in Young's Hotel, at Boston, ther were but 25 members. Now there are 391. The treasury has a balance of $1908, and affairs are in a prosperous condition. The members should educate themselves in

regard to the varying and increasing problems of water supplies. The manner in which disease germs are carried in flowing streams is just being understood. The members may not be sufficiently versed in chemistry to enable them to decide some matters of importance, but they can be educated to be able to handle many of them. A permanent location is needed for the Association, and a place where the Secretary can compile the records and keep them for future reference. There are 325 water-works in New England, and 102 are represented in the Association.

Papers were read on the Ellis System of Fire Protection; on Coating Cast-Iron Pipe; on Detecting Waste, and on the Water-Works of Franklin, N. H.

On the second day two sessions were held, at which papers were read on the Cambridge Syphon; on an Experiment which Failed; on Aëration of Water; on the Venturi Water Meter; on Cleaning Water Mains; and on Land Filtration. There were discussions on several of these papers.

It was decided to hold the next yearly convention at Middleboro, Mass. The following officers were elected: President, George F. Chace, Taunton, Mass.; Vice-Presidents, George E. Batchelder, Worcester, Mass.; F. P. Webster, Lakeport, N. H.; J. L. Congdon, East Greenwich, R. I.; J. A. Butler, Portland, Conn.; F. H. Crandall, Burlington, Vt.; W. E. McAllister, Calais, Me.; Secretary, R. C. P. Coggeshall, New Bedford, Mass.; Editors, Dexter Brackett, W. H. Richards; Executive Committee, F. E. Hall, J. E. Tenney and George A. Stacy; Finance Committee, F. H. Andrews, A. R. Hathaway and J. L. Harrington.

Between the sessions and after the adjournment the members made visits to the water power and other points of interest in Holyoke and the neighborhood.

Franklin Institute.—At the regular meeting, in Philadelphia, May 18, Mr. W. G. Collins read a paper on the Aërated Fuel System of burning petroleum; Mr. C. J. Hexamer read a paper on the proper methods of constructing Public Buildings, with reference to security against fire; Mr. W. N. Jennings exhibited a number of lightning photographs, and described his process of taking them.

The Committee on Science and the Arts on June 1 adopted a report recommending the grant of the Elliott Cresson Medal to Lieutenant Bradley A. Fiske, U. S. N., for his invention of a range and position finder for naval and other service.

At the regular meeting, June 4, it was announced that at the last meeting of the Board of Directors, held May 31, Professor L. F. Rondinella was appointed Secretary of the Club, for the unexpired term of Mr. John C. Trautwine, Jr., resigned.

No paper was presented, but there were discussions on the Location of the New Mint; on Shearing of Iron and Steel, and on the proper proportions of Valve-area to Cylinder-area in high-pressure pumps. Nearly all the members present joined in these, and some interesting facts were brought out.

Engineers' Club of Philadelphia.—At the meeting of May 7 the discussion of the trolley system for running electric cars was continued. Papers were read by Messrs. Carl Hering and C. H. Roney, and the verbal discussion was carried on by Messrs. Hering, Salom, Ford, Smith and others, some interesting statements being given.

At the meeting of May 21 the resignation of Mr. John C. Trautwine, Jr., as Secretary was accepted, with expressions of regret.

The tellers reported the following gentlemen elected members:

Active: Edward H. Jenkins, B. Antrim Haldeman, William G. Hartranft and Clement B. Webster.

Associate: J. Walter Douglas.

The Secretary read a description of blue prints submitted by Mr. C. S. Sims, Jr., and exhibited, descriptive of designs for an Aerial Watch-box for railroads.

Mr. Teile Henry Müller read a paper upon Evaporation by Multiple Effect. The paper was illustrated by a number of blue prints, representing different forms of multiple-effect evaporators.

This paper was discussed by Messrs. Müller, Morris, Falkman and others, who gave some experiences with refrigerating machinery.

Engineers' Society of Western Pennsylvania.—At the regular meeting of the Society in Pittsburgh, May 17, Mr. John W. Seaver read a paper on Iron Mill Buildings, the object being to give a brief description of some of the most important points in the construction of Mill Buildings in such a way as to enable a party who contemplates the erection of a building to decide upon what will give him the most satisfactory return for his money, and to compare the merits of the various plans and proposals that may be submitted for his consideration.

In the paper as read before the Society there followed a complete enumeration of the various points in the design of a building and a specification of loads to be allowed, for quality of material required, unit strains for members, etc.

At the regular meeting of the Chemical Section on May 24, the following officers were chosen: Chairman, John W. Langley; Vice-Chairman, Dr. Charles B. Dudley; Secretary, James O. Handy; Representatives on Board of Directors, James M. Camp and George Marsh.

The Committee on Handy's Phosphorus Method reported that it would be necessary to modify the procedure in analyzing ferromanganese and speigel, as the phosphorus and carbon in these materials resisted oxidation by permanganate solution, and evaporation to hard dryness gave complete oxidation.

A paper was read by Mr. C. P. Van Gundy on Manganese Estimation in Iron and Steel by Textor's Method, Modified. His results showed that the method with slight modification gave accurate results through a very wide range of manganese percentage. The paper was discussed by Messrs. Langley, Handy, Johnston, Van Gundy and Carnahan.

Chairman Langley then described a new method of estimating Copper in Iron or Steel.

Mr. Handy spoke of difficulties encountered in estimating the percentage of Tin in Tin-plate, and described how it had been successfully done.

Alabama Scientific Society.—At the annual meeting in Birmingham, Ala., May 18, it was decided to hold the next meeting at Birmingham in November.

Dr. William B. Phillips read a paper on the Composition of Alabama Cokes, which was discussed at some length.

The following officers were elected for the ensuing year: President, C. A. Meissner, Birmingham; Vice-President, T. H. Aldrich, Blocton; Secretary, Dr. Eugene A. Smith, Tuscaloosa.

Engineers' Club of Cincinnati.—At the May meeting of the Club three new members were elected, and one application for membership was received.

In place of the usual paper on some engineering topic, Mr. E. J. Carpenter, of the United States Engineer Department, entertained the members and their ladies with a lecture, illustrated with lantern pictures, on the subject "Photography as an Aid to Engineering." The lecture dealt principally with the work performed by the dredging fleet on the Ohio River, of which Mr. Carpenter is in charge. The balance of the evening was spent in the discussion of a light repast and in general sociability, and the whole proved an agreeable diversion from the usual programme.

Engineers' Clubs of St. Paul and Minneapolis.—A joint meeting was held in St. Paul, Minn., May 21. Before the meeting the members inspected the new bridge shops and foundry of the Gillett-Herzog Manufacturing Company, of Minneapolis. At the meeting Mr. Wilson, of the St. Paul Society, read a paper on Tunnels in St. Paul and Vicinity, which was followed by some discussion.

Technical Society of the Pacific Coast.—At the regular May meeting in San Francisco the following members were elected: William H. Davenport, Visalia, Cal.; W. O. Secor, Albuquerque, N. M.; Robert Hall, M. M. O'Shaughnessy, Alexander Watson, San Francisco.

The main proceeding of the evening was a lecture on Silver and its True Place in Circulation, by Mr. J. W. Treadwell. This included a review of the circulations of the various nations of the world.

At the June meeting Mr. Marsden Mansen read an interesting paper on the Circulation of the Atmosphere of the Planets.

Engineers' Club of St. Louis.—At the regular meeting, May 18, a paper on Maximum Stresses in Draw-bridges, by Professor M. A. Howe, was read, and was subsequently discussed.

Professor Johnson exhibited an apparatus designed by him and constructed by Maher & Company, St. Louis, for measuring the elongation or compression of test specimens while under stress. It consists of two collars fastened to the speci-

men by set screws, each carrying a graduated circle four inches in diameter, over the face of which moves a balanced pointer. This pointer carries a small vernier and is attached to a spindle, in which is a friction roller measuring exactly one-half inch in circumference. The roller on one spindle is operated by an arm which is attached to the other collar, these arms being mounted symmetrically on opposite sides of the specimen. The apparatus reads with exactness to the nearest one-ten-thousandth of an inch, and registers elongations beyond the elastic limit as readily as it does those below that limit. Its operation is very satisfactory.

AT the regular meeting, June 1, the usual routine business was transacted and subscriptions to the leading engineering papers ordered.

Mr. Flad presented some diagrams showing loss of head for the flow of gases through pipes of varying diameters and for varying velocities. Discussion followed by Messrs. Wheeler, Colby, Flad and Love.

Mr. Ockerson exhibited blue print diagrams showing the effects of erosion on the Mississippi River banks, from Cairo to Donaldsonville, from 1877, 1883 to 1892. The diagrams showed graphically the annual amount of caving per mile of river considered in sections of 10 miles. Discussion followed by Messrs. Colby, Wheeler, Flad and Crosby.

NOTES AND NEWS.

A Large Plate Girder Bridge.—The Boston Bridge Works at Cambridge, Mass., recently shipped two heavy steel plate girders, to be placed over Southbridge Street, Worcester, for the Providence & Worcester Division of the New York, Providence & Boston Railroad.

The two girders, each 95 ft. 8½ in. long, were put together in the shop and shipped in single pieces.

Each girder is 9 ft. deep, too wide to safely lie flat on a car. They were therefore loaded on edge, each on three long flat cars. Each girder weighs 57,715 lbs.

The bridge structure will be 17.4 ft. wide, and will be supported by these two girders, resting on stone abutments.

An interesting feature in the construction of this bridge is its floor plan. The foundation is a series of steel V-shaped troughs, side by side, lying transversely to the tracks and resting in sockets riveted to the girders. The troughs are bent at right angles and are about 18 in. deep.

These are to be filled with cement or concrete, and over this will be placed the material of an ordinary roadbed. The result is a thorough protection of the bridge floor from fire or storm, the deadening of sound, and the making of a tight and solid floor.

Petroleum Burning in Russia.—A number of locomotives on the St. Petersburg-Moscow and the St. Petersburg-Warsaw lines, in Russia, are now being prepared to burn petroleum. Experience with oil-burners on the Southwestern Railroad has shown that oil can be supplied at a cheaper rate than coal to almost any of the Russian lines, except, perhaps, those in the Baltic provinces.

Lengthening a Stand-Pipe.—Owing to the steady growth of Mt. Vernon, N. Y., it became necessary, in order to obtain greater pressure for elevated points, to enlarge the stand-pipe. The old affair was originally 100 ft. high, 20 ft. in diameter, and weighed about 75 tons. It was built of 5-ft. plates, double riveted vertical seams, and had a capacity of about 235,000 gallons. To increase the pressure the stand-pipe was raised 25 ft. with handjacks and blocked. The extension of 25 ft. was made of tank iron, 12½ ft. of ⅜-in. and 12½ ft. of $\frac{5}{16}$ in. iron, having a tensile strain of 50,000 lbs. per sq. in. of section.

The present height of the stand-pipe is 125 ft.; diameter, 20 ft., with capacity of about 300,000 gallons. The stand-pipe was raised in thirteen days. The placing of the extension and connecting force main took nearly thirty days. The cost of the entire work was about $5000. Isaac A. Blair & Company, of Boston, did the raising, and the iron work was done by the Cunningham Iron Works of South Boston.—*Fire and Water.*

An Old-Time Sound Boat.—Our marine contemporary, *Seaboard*, is publishing a very interesting series of articles on the old-time steamboats of Long Island Sound. From one of these we take the accompanying illustration of the *Chancellor Livingston*, which was built in 1815. The history of this boat is given by *Seaboard* as follows:

"She was designed by Stoudinger, and was two years building; when finished she was the most elegant steam vessel in the world—the *Puritan* of the steamboats of that day. Her hull was built by Henry Eckford, and the joiner-work executed under the direction of David Cook. Her engine and boiler were constructed by James P. Allaire. Her boiler was of copper, but on a new model, having a large cylindrical flue, with two small return flues and a false front. She was the first boat having a cabin on the main deck, with a promenade above. She cost, complete, $110,000.

"The *Livingston* made her trial trip on Saturday, March 29, 1817, going to Newburg, a distance of 60 miles, which, according to those on board, 'was accomplished in a few minutes less than nine hours, of which time the tide was in her favor only three hours. In returning, the same distance was run in 8 hours and 15 minutes, the greater part of the time against a flood tide and south wind.' It was expected that she would go to Albany in about 20 hours, and she did a number of times. Her fastest run that year to Albany was on December 5, when she went up in 18 hours.

"The *Livingston* continued on the Hudson until March, 1828, when she was placed on the New York & Providence line as an opposition boat, with Captain Coggeshall in command.

THE "CHANCELLOR LIVINGSTON," 1828.

She had been rebuilt during the winter previous, and now appeared with three boilers and three smoke stacks, as is shown in the illustration. The other steamers running between the two places were the *Fulton*, *Connecticut* and *Washington*. The steamboat *Long Branch* was placed on the same route later in the season, and a new boat, the *Ben Franklin*, appeared in September that year. The latter was said to be the best boat on the Sound, but it was claimed that the *Livingston* was the fastest. The *Livingston* continued to run for a number of years. She became a great favorite, and the superb meals that were always to be had on this boat added not a little to her popularity. She ran independently during 1831–32, keeping the fare down, and the steamers *President*, *Connecticut*, *Providence*, *Franklin*, and *Boston* were on the other lines. In 1834 the *Livingston* went to Boston, where she struck a rock in the harbor and sunk. She was raised again and placed on the Boston & Portland line, where she ran for a number of years. Her hull having been condemned, it was broken up and her engine put into the new steamboat *Portland*."

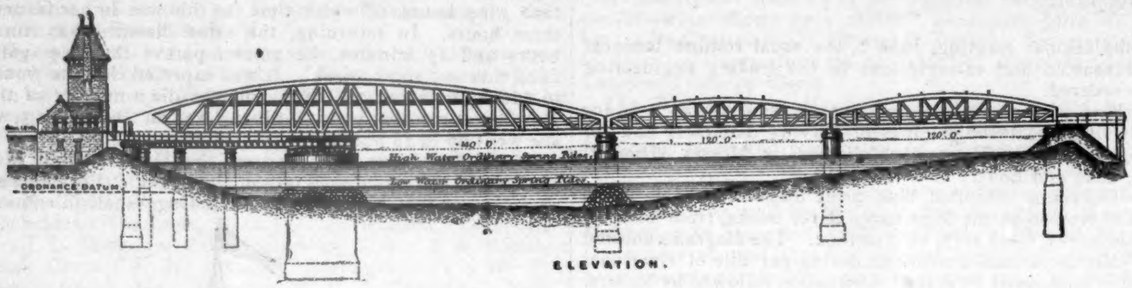
The Hawarden Bridge.—A paper recently presented before the British Institution of Civil Engineers by Mr. Francis Fox gives a description of the Hawarden Bridge over the River Dee, built under his charge, which has the longest clear opening of draw span in England.

The bridge consists of two fixed spans of 120 ft. each, and of one swing portion, 287 ft. in length over all, which gives two unequal openings, the largest of which, being for the navigation, is 140 ft. clear span, while the tail end of the girder gives a clear span of 87 ft. The bridge carries a double line of railroad, with a footpath, 4 ft. in width, supported on cantilevers outside the main girders.

The piers are founded on brick wells, a system much used in India, the brick columns or wells built in iron caissons sunk in the bottom of the river, which is of soft, shifting sand.

The swing bridge consists of two main girders, constructed of mild steel, each having a total length of 284½ ft., and a total

depth of 32 ft. at the pivot, and 9¼ ft. at the ends. The pivot is 116¾ ft. from the tail end, and 168¼ ft. from the fore end of the girder. The girders are 27½ ft. apart, center to center; and the clear width inside is 25 ft. 2 in. The girders are lattice, divided into panels, 17 ft. wide, with single, triangulated, vertical and diagonal members, except over the pivot where the members cross each other. The top booms are curved and bow-shaped, and the bottom booms are horizontal. The sections of the various members are of the simplest form, the connections being made by junction plates and rivets; and smith's



THE HAWARDEN BRIDGE OVER THE RIVER DEE, ENGLAND.

work was avoided wherever possible. The bottom booms are of a square trough section, and the top booms are the same, but inverted. The lattice members are of I girder section, made of plates and angle irons. The short end of this span is provided with a balance weight to counterbalance the additional length of the other end.

The draw-span is moved by two hydraulic rams placed on heavy bed-plates on the center pier. Both rams are single acting and are geared with chains in the proportion of 2 : 1; one ram opens and the other closes the bridge, the chains acting on the central bearing. The rams are 19 in. in diameter and 151 in. stroke, this being sufficient to turn the bridge through an angle of 90°. The boilers, pumps and accumulators are in a building at the Cheshire end of the bridge, which is shown in the engraving.

An Indian Suspension Bridge.—The accompanying illustration, from *Indian Engineering*, shows a suspension bridge which has stood the test of long service, and which was built

SUSPENSION BRIDGE OVER THE BEOSI RIVER NEAR SAUGOR, INDIA.

wholly from native Indian material and by native labor, from the designs and under the direction of Major Duncan Presgrave. It carries a highway having a large traffic, and crosses the Beosi River near Saugor.

The foundations of the bridge, which was designed with one span of 200 ft. between centers of suspension, were laid in April, 1828, and the bridge was opened for traffic in June, 1830.

The abutments were built of stone quarried in the neighborhood, set in mortar also made of locally burned lime, and rose up from the rocky bed of the Beosi River with a batter of 1 in 5 to a height of 42 ft. over the rock, showing a clear height of 36 ft. over low water surface, the batter giving an impression of massive strength in keeping with the surroundings of the bridge. The abutments were continued on into wing walls which ran into the banks on either side a distance of 26 ft., rising up with a batter of 1 in 8, this being also the batter of the abutment faces in line with them.

The points of suspension were designed in the ordinary way over the haunches of the archway over the abutments, the roadway passing under cut-stone faced archways 15 ft. in height, and the arches themselves resting on piers 6 × 12 ft. in section at road level.

As finally built, the masonry, including the arches for the suspension chains, rose to a total height of 68 ft. above the rock of the river, and 62 ft. over low water level. Local masons, stone-cutters, and quarrymen, and locally contrived slings for lifting the stone and setting the blocks in position, were used exclusively and with complete success.

The rich iron mines of Bijawar and its vicinity, through which all the three great northerly roads from Saugor pass, furnished an exceedingly pure iron ore, which, smelted in the vicinity of the mines with charcoal from the local forests, furnished the irregular round lumps from which, in the workshops at the bridge site, the finished suspension chains were finally turned out, wholly by local labor; the links of the main chains 15 to 15½ ft. in length of round 1½-in. bar iron, the heavier square anchoring chains, the suspension saddles and the rollers were all forged in these workshops, where also all the bolt holes, the bolts, the nuts, the washers, the suspenders and their stirrups were forged, turned, fitted and had the necessary key-slots cut in them. Lastly, even the longitudinal roadway girders, of flat bars ¾ in. thick, 4 in. broad and 15 ft. long (on which the wooden cross beams carrying the roadway rest), and which were carried in the stirrup-loops of the suspending rods, were forged on the spot. These, if not the most difficult in one sense, were certainly the heaviest forgings needed.

The workshops, under Major Presgrave, successfully turned out all the complicated iron-work with a finish little inferior to machine, finished work, and of a strength far exceeding in its charcoal smelted purity the strength of any ordinary English machine-rolled iron.

The 12 suspending main chains ranged in 3 *pairs* on each side, 2 ft. apart vertically, weighed 8½ tons, the flat 4-in. bars for carrying the roadway across joists weighed 1¾ tons, the suspending rods weighed nearly 1½ tons, and the miscellaneous work, nails, bolts, cornices, string course, etc., altogether brought up the net weight of iron-work, *as it was turned out from the workshop*, to 14¾ tons. The paint to cover the iron-work is not included in the above; it weighed 1⅝ tons on its own account.